SCHOOL SCIENCE AND MATHEMATICS

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GREETINGS AND ANNOUNCEMENTS.

With the first number of the fourteenth volume, this Journal sends greetings to its subscribers and readers scattered the world over. Our phrase, "we cover the earth," is literally true as this Journal goes into every country on the face of the globe. We wish to thank our subscribers and contributors for their support and the many favors rendered during its past history. It has been only through the efforts of our constituency that we have been able to maintain the high standard of these columns. We ask for continued support in our endeavors to produce a secondary school Journal which aims for the promotion of science and mathematics teaching to the highest possible standard. It is our purpose to produce a Journal which will do the most good to the greatest number. Criticisms and suggestions as to how we can improve it, will be gladly and thankfully received. Plans have been made for a rigorous and far reaching campaign during the coming year for better teaching, and all this implies. We ask for contributions concerning new schemes and methods both in class-room and laboratory.

Recognizing the growing importance of scientific Agricultural teaching in secondary schools, our management has decided to establish a department of Agriculture. Fortunately for our readers Professor A. W. Nolan of the University of Illinois has consented to take charge of this branch and under his management there is no question but that this phase of the Journal's work will be eminently successful.

It is with regret that, on account of an increase in outside work, we announce the severance of that able man, Dr. A. L. Smith, from the head of the chemistry department. We are very fortunate, however, in securing another exceptionally able man for the position in Mr. Frank B. Wade of the Shortridge High School, Indianapolis, Ind.

A FEW CRITICISMS AND SUGGESTIONS FOR THE TEACHING OF HIGH SCHOOL ZO-OLOGY.

By Harold B. Shinn.

The changes which have been at work in the high school zoology courses for several years have been toward physiologic and economic features and away from morphologic and taxonomic principles. These changes have been too slow, a great many teachers think, and yet they can hardly be otherwise because they must first occur in the teacher's own viewpoint. Our real training for zoölogical teaching was usually obtained in college laboratories under the instruction of men whose interests lay in fine details and profound truths and whose tools were the scalpel, the microscope, and the microtome. Upon leaving the college laboratory to take up work in secondary schools we did those things we knew how to do; we cut and pried and peered. To make matters worse, the only text-books available were those written by the very men who trained us, or else, if there were other books, we selected those which taught the things we knew.

One very immediate result of this has been an unnecessary duplication of work. This obtains in other sciences as well as in zoölogy. A recent high school graduate who is now a college freshman writes: "Chemistry here is easy, for it is just the same as what I had in high school." Besides being almost wholly unnecessary such repetition is an expensive loss of time, energy, and interest on the student's part. A recent conference in the University of Chicago took up this matter of "Economy."

It generally required several years for us to realize that the interest and capability of high school boys and girls is not in the collegiate work which so engrossed our attention, but rather in the broad world of which they are integral parts. Their eyes are not fitted for microscopic work nor should much of such strain be given them at this period of great physical change and development. Their brains are incapable of prolonged study upon a difficult phase of animal or plant life. Few of their minds really grasp the import of those truths upon which we set them to work.

Yet we cajoled our pupils through the course, straining their mental and physical energies close to the breaking point; witness the disparity in numbers between the incoming and outgoing classes! We splashed about in the edge of great things, such as alternation of generations, morphology and homology of arthro-

pod appendages, evolution of protozoa, or mitosis and reducing cell-division, collegiate features which should have been left for the higher laboratory and a more adequate treatment. We almost fatally warped the child's viewpoint into that of fussiness and minutiae. We utterly overlooked the zoölogy of their own life, their own relationship to external factors and conditions, dismissing them with the notion that zoölogy treats mostly of oddities, of invertebrates and marine forms, and that animals cannot be studied unless they be preserved, dissected, or pictured on a German chart. Such presentation was unfair to the pupils and unfair to the subject; the classes deserved a broader treatment and the subject was capable of it. The cause of this, I maintain, was our training and the methods of the text-books available.

May I be allowed to suggest here that instead of the emphasis being placed upon the anatomy of an insect, as that of the appendages, mouthparts, or viscera, it be put upon the wonderful adaptions of these parts. For this reason the three legs of the honey-bee furnish far more entrancing studies than do those of the locust because of their remarkable adaptions for eye-brush, antenna comb, pollen basket, and wax nipper. The bee's mouthparts stated as pry, tongue, and trowel embody the same method of attack. Similarly, the adaptions of beaks and of feet; of scales, plumage and fur; the relationship of heart structure to oxidation and body temperature; of teeth to diet and disposition; of diet to edibility, defense, home and size of litter; of eye structure to vision; these and other suggestive topics keep the pupils mentally alert. Anatomy precedes psychology and both involve adaptation and distribution.

Inherent in every boy and girl is a desire for possession; this can easily be utilized in the making of such zoölogical collections as those of insects and of shells. The teacher can arrange to have the first prepared in the fall and the second in the spring, or *vice versa.* The amount of material would vary, of course, with the season and the locality. During the shut-in days of winter there might be prepared a scrapbook of mammal and bird pictures.

Neither the reader of this article nor the pupil should get the notion that these collections are the sole end of the work. They are simply a means of arousing and sustaining interest in zoology as a school study. All the while class work goes along its more or less well beaten path, little or nothing being said about

the collections from the time they are started until they are brought to school for inspection and credit. Incidentally, many collections will be left and can be utilized for the upbuilding of a school museum. For the insect work, buy and place in pupil's bottle the cyanide and plaster and furnish the pins, the total expense being apportioned among the pupils. Shells require no initial outlay unless a club order be purchased from some dealer. Several other collections suggest themselves, such as animal products for clothing and food, or photo-albums of animal pictures.

Mammals, particularly domesticated ones, deserve far more attention than they usually receive. In our slavish infatuation for the evolutionary series we reserve for them the last place; generally they are crowded entirely out of the course by over development of lower topics and by examinations and holidays. Mammals can be easily studied during winter by means of living material such as rabbit, white rat, guinea-pig, dog, or cat, and by means of various pictures and supplementary reading books.

In the Schurz high school we keep a few pet mammals all the winter; we rent a living monkey for the days when we study *Primates*; we bring to school pet dogs which exemplify various valuable breeds; we don wraps and go out to the street to study the horse. By means of lantern slides, stereoscopic views, and certain colored post-cards which are pasted in the note-book we formulate primary exercises or others which supplement the living material, upon sheep, cattle, the horse, the elephant, the bear, the hyena (for dog), and the monkey.

The mammal studies requiring several weeks of winter, fur, body heat, and hibernation, are timely subjects. Comparative studies of legs, of teeth, and of skulls are required. The zoölogy of man is called for; the bronze age, the lake dwellers, the cave man, the domestication of common animals and plants are vivid topics. Neolithic conditions are recalled by the use of Indian relics. Pithecanthropus becomes more than a possibility; he is a probability, an interesting character. Pupils and teacher come to feel that they understand their own independence and interdependence better than before; they have a better appreciation of domesticated animals and a fuller knowledge of wild ones.

The work in domestic zoölogy grades into the topics of crossbreeding, Mendelism and mutation. It discloses a vista of possibility in the discussion of heredity, of eugenics, and of sex hygiene. Careful and judicious treatment of these topics in mixed classes has met with no criticism from any source, but

is regarded as one of the most interesting features of the course.

Following the mammalian studies, and just at the right time, too, come those of birds, for about now the spring migration sets in. For their field work the boys and girls now have a broader mental vision and a keener appreciation of returning spring with its portent to animal life.

The writer's conviction and experience are that the new course leaves to the college what really belongs there, avoiding duplication, and places before the high school pupil many of those things zoölogical which appertain closely to his life. Criticism will be made that such treatment as that outlined here is "nature study": let us hope so; that it is "natural history": let us hope so; that it is a marked degeneration of old line zoölogy: may we substitute "regeneration," for results indicate a wider and deeper interest on the pupil's part and a kindlier feeling toward other creatures.

DIRECT SEEDING GIVES GOOD RESULTS.

Pine seed sown directly in the spots where the trees are to grow is yielding good results in young trees on the Tahoe national forest in western California.

This is in marked contrast to the usual results in such cases, because squirrels, mice, and birds will eat the seeds where they are planted without protection, and even when these enemies allow the seed to germinate, the drying out of the soil in drouth periods is usually too much for the tiny seedlings during their first season.

Because of these vicissitudes foresters usually find it advantageous to grow the seedlings in nursery beds, where seeds and plants can be protected by wire screens and shade frames, and where water can be applied when needed. Usually, too, the seedlings are transplanted once or twice before they are set out in their final situation, the transplanting process serving to develop stocky plants with compact sturdy roots. While the nursery bed and transplanting process involves more work, it is said to be generally cheaper in proportion to results accomplished, particularly when the cost of seed is taken into consideration.

The California experiment, which indicates the possibility of direct seeding of certain species in some localities, was conducted on an area of 22 acres, sown in the fall of 1910 to Jeffrey pine. A large number of seedlings have become thoroughly established and have made thrifty growth. The plantation is at an altitude of 6,000 feet where there is more moisture than at lower elevations.

When the seeds were planted they were covered with red lead to discourage mice and other rodents, but so far as the forest officers could find out the lead coating had no such effect; not enough of the seed was eaten, however, to destroy the value of the planting.

ESSENTIALS OF A PRACTICAL COURSE IN BIOLOGY.

By George C. Wood,
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The most important avowed function of biology in the secondary school is to make of every pupil studying it, a good animal. That means the conservation of the individual and of the race. A second function of biology is to prepare the pupil for efficient citizenship. The nature of the material to be used in accomplishing these two great functions is unimportant provided the objects are accomplished. The personal equation is the determining factor—the personality and enthusiasm of the teacher.

Beyond these above mentioned functions, there is no doubt a cultural, a utilitarian and a disciplinary value in the study of biology. These three considerations may have something to do with the teacher's preferences as to the material to be presented, but they are all summed up in the one word "practical." It is from the practical standpoint that I desire, in all humility, to indicate what topics may be included in a course of biology for the first year of the high school, approximating thirty-six weeks (twelve for plant biology; nine for animal biology and fifteen for human biology) with particular emphasis upon the point and method of attack. The great lack in so many courses of biology is a *unifying* scheme; a method; a plan, which the pupil can see as well as the teacher.

First, then, let me lay down just two propositions, as follows:

(1) *I believe that the average pupil will be more interested in subjects or topics concerning which he knows something, rather than in the topics of which he has little or no knowledge.*

(2) *I believe that there is just as much disciplinary, cultural and practical value in a study of the common and economically important objects in nature as in the study of forms of which the pupil has never heard before and may never hear again, unless he be a very wide reader and the general supposition from the premises is that this he will not be.*

The only excuse that any teacher can have for teaching the secondary school pupil the variable forms of the unimportant cryptogams or invertebrates is to satisfy his own longing to promulgate the grand old theory of evolution. Theory? Why, it is a fact! Why necessary to still drum that into the inoffensive adolescent ear!

To say that a study of such forms is beautiful may be true. It

is even possible that the pupil shall know something about all the forms of plant and animal life. Truth is always beautiful, but life is short and it is the business of each generation to crystallize for the next generation the most exact and useful information which will contribute most to its happiness, its prosperity and its success.

What to teach and how to teach it is the all-absorbing question. The field is large and complex. There must be some central axis; core; unit; call it what you will, about which all topics *naturally* and *logically* revolve. Among these topics there must stand out large principles; moving truths; upon which all subsequent reading and study of the pupil in after life may depend. Shall it be Structural Biology? May good sense forbid it. Shall it be Type Biology? That is some better! Shall it be Synthetic Biology? That sounds admirable! Shall it be Functional Biology? That, above all, is most natural and most vital! Shall it be Functional Biology with a view to its bearing upon the conservation of the individual, the city, the state and the nation? That is the ideal! That is something to be sought! But how do it? What methods are to be pursued to attain such ideal? This is hard to answer. I can only give suggestions, which may have in them a tendency towards the solution of the problem. A provisionally adopted course in our school attempts to get at the problem. I say "provisionally" because this course is modified and newly adopted almost every month.

In addition to the propositions laid down above, let me add three more of lesser importance, which guide us in the selection of material for study.

(1) *Common things, which are at the same time of economic value, are studied.*

(2) *Function is raised to an exalted position at the very beginning of the course.*

(3) *Where possible, a practical application is made of every point to the welfare of the individual.* The whole subject is *socialized.*

Biology is the study of *Life*—a unit principle manifested in a single substance—protoplasm. The pupil is interested in seeing how it acts—how it manifests itself—what it does. Now this protoplasm manifests itself in myriad ways—as a single cell and as many cells in one organism.

Bacteria, sequoia trees, ants, elephants and men—all constructed of this fundamental substance, made up of five elements, non-

living, separated, but alive when combined in the right proportions. What, then, is the object of presenting to the pupil a great category of animal and plant forms, for individual dissection and study when he learns at once that the substance composing them is identical. It simply shows itself in various forms.

It is far more reasonable to show the pupil that *simple existence means something.* Things made of protoplasm are alive and live things have needs which must be fulfilled, else the organism dies. These needs are fundamental and four in number. They are (1) Food, (2) Air, (3) Protection, (4) Reproduction. The only structural work needed in the whole course is to show the pupil how the type animal or plant is adapted to best fulfill those needs. Simple, isn't it? That is the whole substance of our course of study.

Four needs—three for the individual and one for the race—and you have the sum total of all life. Here you have your beginnings of altruism, social feelings and coöperation at the start. Here your cultural as well as your practical side begins.

The Structuralist now comes forward and says:

Give the pupil the microscope. Place beneath its objective a few root hairs and direct the pupil to make a careful drawing of these root hairs, showing them as a part of the epidermal cells of the root. Let him label all the parts (as given by the teacher). Very well! When he is finished, ask him: What is the function of the root hair? Silence. Next ask him: How does the root hair do its work? No answer. The inevitable result is, that the teacher tells him what the root hair is, how it works, and thinks that the lesson is a huge success. But why spend all the time drawing? What connection is there between the drawing and the ultimate knowledge of function which the pupil needs? Absolutely none! The cart is before the horse! What conclusions can the pupil draw? He never draws any conclusions. The work becomes distasteful to him; he sees no plan in it; his mind refuses to work; there is nothing for *him* to do.

The fundamental needs of life can be brought out in a few minutes' discussion with any class in the presence of a growing plant or a kitten. The pupil is at once brought up square against all the natural operations of living things familiar to the child and with entire frankness and absence of cant. Interested? There can be no doubt of it! It is vital, familiar and practical.

A further study of a thrifty plant elicits many questions. What are the uses of the parts seen? Of what are they com-

posed? Why are the roots in the ground? What do they do? What increases the bulk of the plant?

The questions are answered by the pupil himself after a few simple observations of chemicals and experiments upon the nature of soil and plant tissue. He finds them in many cases identical. The pupil finally concludes for himself that all life primarily depends upon the soil and air for its existence—in fact, is soil in a modified form. This opens his eyes. He is *seeing* and *feeling* things. He begins to get his bearings as a living thing. He possesses a viewpoint and this is of more value to him than all the structural study in the universe.

But how does the plant grow? Let the pupil find out for himself. Let him light a match. He finds that it burns; finds by test that it gives off heat, water and carbon dioxide. He finds by analogy that heat is energy because it drives the train along the track; that a growing plant gives off heat, carbon dioxide and water and strange to say, he, the pupil, is warm, gives off carbon dioxide from his lungs and produces a film of moisture on a window pane when he exhales upon it. He finally concludes himself and the plant to be engines as well as the locomotive, and that both have very similar needs and that both are adapted in certain ways peculiar to themselves to fulfill those needs. He has discovered some of the fundamentals of life as far as any of us know them and has done it himself. Ah! that is the appeal to the child. He did it himself. How his eyes brighten! How his face shines! And he sneaks up after the recitation and tells you he likes biology.

Now bring in your structure carefully and gradually. The pupil will devour it with the enthusiasm previously generated. It will seem of vital interest to him now because (1) it will allow him to organize his own ideas; (2) it will provoke him to serious thought; (3) it will develop his limited individuality; (4) it will enhance his power of expression; (5) it will give him growing confidence in himself; (6) it will end in real accomplishment which is the finest flower of logical and enthusiastic effort. To make my point concrete, let me set down here a small portion of the course as we have blocked it out. This is considered the minimum work required and I have selected this topic because it is one in which the boys, by actual test, show the least interest of all the topics in Plant Biology.

Topic E. Stems.

A. (a) Need of Stems and Their Use to the Plant.
- (1) Support.
- (2) Conduction.
- (3) Food Storage.

(b) Structures Adapted for these Functions.
- (1) Support.
  - (a) Monocotyledonous—rind.
  - (b) Dicotyledonous—bark and wood.
- (2) Conduction.
  - (a) Monocotyledonous—ducts.
  - (b) Dicotyledonous—ducts of sap wood and bark.

Demonstration of Capillarity.
- (3) Food Storage.
  - (a) Monocotyledonous—Pith.
  - (b) Dicotyledonous—pith, medullary rays, sap wood.

B. Use of Stems to Man.
- (1) Food (potato, etc.).
- (2) Medicines (quinine, etc.).
- (3) Condiments (cinnamon, etc.).
- (4) Aromatics (camphor, etc.).
- (5) Manufactures and Arts (building material, lumber, furniture, tannin, cork, rosin, turpentine, etc., etc.). Recognition of five most commonly used trees. Study of tangent and quarter sawed blocks of wood with reference to relative values.

C. Care of Trees.
- (1) Pruning and its use to the Plant.
- (2) Protection against mammals, insects and disease.
- (3) Conditions for proper growth.
- (4) Civic value.

D. Methods of Growth.
- (1) Cell expansion (monocotyledonous).
- (2) Cell multiplication (dicotyledonous).

E. Methods of Propagation.
- (1) Grafting—Purposes—Results.
- (2) Stem cuttings (fruit trees).
- (3) Underground stems (potato).

Function here precedes structural in both order and importance. The pupil sees a plan and method in the whole proceeding; his curiosity is naturally and logically satisfied. He learns without

knowing it. Incidentally he is being educated. He is studying civic biology with no dollar mark attached.

In the topic on flowers, the fundamental conceptions of sex hygiene are set forth, and yet, without the knowledge of the pupil. The flower's purpose as fulfilling the fourth great need of living matter is explained or discussed, by the study of one regular simple flower. The economic value is secondly developed, followed by "Three Steps in the Formation of Seed"—(1) Pollination; (2) Fertilization; (3) Changes in the flowers following fertilization (loss of parts and maturing of others). Great emphasis is placed upon the essential conditions of fruit production—the union of two dissimilar cells to form a third cell—having the characters of both parents. The fruits follow naturally; the seed is shown protected in an ovary wall until maturity, fed by the mother plant; and the final scattering is discussed with means for accomplishing it. The relation of this process to that of the higher animals is obvious and it is an exceptional class where one or more boys do not see it and either mention it or ask questions concerning it. Plant breeding and its application to plant improvement are here brought out, making the impression vivid, practical and lasting.

But to proceed. The ultimate result of the study of plant life is to develop in full detail the four great needs of protoplasm and how these needs are met. The swing into zoölogy is gradual and natural. The pupil is armed with his four great principles and shows an instant interest in their application to animal forms. Animals are first discussed at length as a part of the natural resources of the country—wild and domestic; useful and harmful. A rapid resumé of the chief groups of the animal kingdom follows, giving the pupil an intelligent idea of where he is starting, why he starts where he does, and why he cannot study the whole animal kingdom. He begins with the insect, for many obvious reasons, which he is taught to see for himself. The four great principles are applied at once.

Let us give an outline here of the course on the second type animal—the fish.

Topic M—Perch as a Type of Fish:

A. Conditions Necessary for Life.

1. Food getting.

(a) Kinds of food and how obtained. Structures adapted for this purpose (paired and unpaired fins). Relation to escape and higher animals.

(b) Method of feeding. Structures and their relation to the struggle for existence.

2. Respiration.
   (a) Method of breathing.
   (b) Structures for breathing. Gills and how guarded and constructed to obtain maximum amount of oxygen.
3. Reproduction: Life Cycle.
   (1) Egg-laying.
   (2) Fertilization.
   (3) Young.
   (4) Adult.
4. Protection: Defensive (a) color, (b) scale, (c) spines, (d) fins, etc. Offensive: Teeth and spines (in some cases).
5. Economic Value.
   (a) Useful—foods, byproducts.
   (b) Harmful—destruction of food fishes.
   (c) Laws of Protection (open and closed season, etc.). Work of state and federal governments.

Here again function precedes structure, but structure has its place. Drawings are made of the head showing the gills. Demonstrations are made of the general plan of the interior from specimens prepared in jars. But very little of this is done, however. This plan is followed in birds and mamals. Among the mammals, the herbivores and carnivores are greatly emphasized. The course in zoölogy is closed by a week's work on parasites, a review of the fundamental needs of all life and an outline of the animal kingdom showing the increasing complexity from the Protozoa to man.

Human biology opens with a discussion of the fundamental needs of living things. The first, that of food, is at once applied to the human body. Foods are studied in all their applications (preparation, composition, kinds, adulteration, laws, etc.). Then follows the apparatus in the body for using foods with simple experiments on digestion of starch, proteids and emulsification of fats. The blood system is found to be simply an extension of the digestive system—an ingenious method of getting the food where it is needed. The functions of the blood are clearly brought out. The hygiene of both systems is specially emphasized. The need of air is discussed, as a need of the body. Its nature, composition and the apparatus using it are correlated,

but function holds sway over structure. Charts and demonstrations are an aid to a reduction of structure study, with just as much, if not more value to the pupil. Dust and its dangers, exercise, disease, construction of heating systems are all developed from the standpoint of function and self-preservation. Protection is a very broad and very important phase of the subject. It is composed of four topics, all closely related, because all are connected with the "locomotor system," which has for its purpose the getting to food or getting away from danger. The skeleton, muscles, nerves and excretory organs are but briefly touched upon, principally from the standpoint of hygiene. Right habits in connection with these systems are dwelt upon at length.

Bacteria next claim attention and here civic biology comes into its own. From one week to ten days is spent upon the nature, kinds, methods of growth and destruction of bacteria in their relation to disease and its prevention. The municipal departments (sewer, street cleaning, water, health) are discussed so that the pupil may know their real purpose and value as a future citizen and that he may show sympathy and coöperation in the attainment of the objects for which they are instituted. The link between the excretory system and sex hygiene is formed by bacteria, and the one week's study of sex hygiene, with a summary of the whole subject closes the year's work. In sex hygiene the purpose and methods of reproduction in all the plant and animal forms studied are reviewed. Man is found to be no exception to the general rule of the fundamental needs. Over exercise of all the principal systems and their bad results serve as an introduction to the presentation of the subject of the abuse of the reproductive system. The sources of disease (such as public lavatories, towels, cups, etc.) are next discussed, and their effects upon the individual and posterity clearly brought out. The subject is supplemented by references to heredity as shown in plant breeding, the Juke family and confirmed criminals. Recent laws are read concerning treatment of crinimals from this standpoint and the topic is closed by an appeal to the pupil's common sense and chivalry as against his morbid curiosity, and sense of shame. This, in brief, is a resumé of some of the essentials of what I am wont to call a "Practical Course in Biology."

COLLOIDAL CHEMISTRY.

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Introduction.

For an indefinitely long period in the history of chemistry, observations were constantly being made upon substances classed as amorphous and crystalline, and their properties were recorded in a more or less haphazard manner. It was not until the close of the 19th century, that an English physicist, Walter Graham, began his classic researches in this direction which resulted in the birth of a new phase of chemistry that has reared for itself today a monumental edifice which still promises a future of untold possibilities.

Walter Graham gave to the substances belonging in this new field of chemistry the somewhat phantastic name, "colloids," and its study is called "Colloidal Chemistry," or better still, "The Chemistry of Colloids," for he was chiefly concerned with the behavior of two different classes of substances. One class, comprising such compounds as NaCl, $CuSO_4$, etc., he found would pass very readily through certain membrances such as parchment paper, while the other class, containing such substances as gelatine, agar-agar, albumen, etc., lacked this property or showed its presence to a very slight degree. The former class he called crystalloids, which means "like a crystal in structure" having the power to crystallize from a solution, and to the latter he gave the name colloids, from the Latin, which means like gelatine, lacking crystalline structure, or in other words, amorphous. Although new phrases and terms have been introduced since Graham's time, his original classification of substances into colloids and crystalloids is still retained.

Definition of a Colloid.

It would not be out of place at this stage to begin with the definition of a colloid, and then through experimentation to verify as far as possible the statements therein contained.

Colloidal solutions may be defined as being either solid or liquid mixtures of two or more substances which are not separated from each other by the action of gravity, by the ordinary mechanical methods of filtration or by decantation; but which are so separated when they are passed through certain animal or vegetable membranes. The substance, then remaining behind,

is designated the colloid. This distinguishes colloidal solutions at the outset from suspensions of fine visible particles which would ultimately settle out on the membrane and true solutions which would pass through and the colloid therefore lies somewhere between these two types in the size of the suspended particles. This process of separation is known as dialysis.

But there are two kinds of colloidal mixtures which are retained by the above mentioned membranes, a type of one being gelatine, agar-agar, etc., and of the other, colloidal arsenious sulphide, colloidal ferric hydroxide, etc. To the discussion of these we shall now turn our attention. For the sake of clearness and convenience I have designated the latter class as "Prepared Colloids" to distinguish them from the former class, the "Natural Colloids."

Methods of Preparation.

(1) *General Principle.*

When an insoluble substance is formed by the interaction of two or more compounds in the absence of an electrolyte or fairly well ionized substance, the insoluble precipitate thus produced will almost invariably be obtained as a colloid. Thus, if a saturated hydrogen sulphide solution, H_2S, from which all traces of any electrolyte have been removed (especially that of concentrated sulphuric acid or hydrochloric acid which may be carried over by the generated gas) is added to an aqueous solution of arsenious oxide, As_2O_3, neutralized by the addition of sodium carbonate, Na_2CO_3, an opalescent, orange-yellow solution will be formed which contains the exceedingly insoluble arsenious sulphide in solution. The solute in this solution will not settle out on prolonged standing or agitation, but appears as a perfectly homogenous solution.

It will be profitable at this point to bring out the fact that we are not dealing with a supersaturated solution. It is well known, that if we dissolve considerable sodium thiosulphate (ordinary hypo) in boiling water we can obtain a solution which contains the solute dissolved far in excess of the amount required by a saturated solution, without any evidence of a solid phase appearing, but if we add the slightest crystal of the same substance, scratch the surface, or centrifuge it, immediate and spontaneous crystallization of the solute will take place. We are therefore dealing with a supersaturated solution. However, if we should add some ordinary solid arsenious sulphide to colloidal arsenious

sulphide, and agitate it, no crystallization will take place. We are therefore in this instance not dealing with a supersaturated solution, but with an insoluble substance in the colloidal condition. We shall postpone the proofs as to its colloidal nature at this part of the discussion.

(2) The second method of obtaining colloidal preparations is through dialysis, which makes use of the fact to which reference has already been made, that certain animal or vegetable membranes will permit the passage of crystalloids, while they retain in the dialyzer any colloid. If a molar solution of ferric chloride, $FeCl_3$ (containing 161.5 grams of the salt to a liter) be carefully neutralized with a molar solution of ammonium carbonate $(NH_4)_2CO_3$ (96 grams to the liter) until the precipitate formed on each addition will barely dissolve, and then filtered and dialyzed against running water, distilled water, and finally conductivity water (it will then contain 2.40 grams Fe_2O_3 to the liter), ferric hydroxide, $Fe(OH)_3$, a very insoluble substance, formed quantitatively according to the reaction, $FeCl_3+3HOH = Fe(OH)_3+3HCl$, will be obtained in a perfectly soluble condition without forming any precipitate. It can be very easily verified as in the case of colloidal arsenious sulphide, that we are again not dealing with a case of supersaturation.

(3) There is still a third method known as that of "Bredig," the discoverer of this process. This consists in passing an electric current through fine wires of the noble metals, gold, silver or platinum, under pure distilled water, containing a 1/2000 N HCl solution, in such a manner that an electric arc is formed. Extremely fine particles of the metals are thus shorn off. If this liquid be now filtered it will be found that a clear and homogeneous appearing solution passes through the filter. If gold wires are used, a red-colored liquid is obtained and the intensity of the color will be indicative of the concentration of the gold particles in colloidal condition.

Properties of Colloids.

We have already seen that there are two distinct classes of colloids, one, the natural colloids as albumen, and the other, prepared colloids, as colloidal ferric hydroxide or colloidal arsenious sulphide.

For the sake of uniformity and logical treatment, I shall deal with the properties of both classes, first discussing those of the

natural colloids, and then contrasting them with similar properties of the other class, that is, prepared colloids, whenever feasible.

(1) *Density, Osmotic Pressure and Diffusion.*

(a) The first striking property that meets our attention in the treatment of colloids, is that their density is very great and that they therefore must have a very great molecular weight. They also exhibit a contraction in volume on increase of concentration, as shown by the following table:

1% gelatine gives a volume of 0.960 cc.
25% gelatine gives a volume of 0.937 cc.
50% gelatine gives a volume of 0.902 cc.

(b) If the osmotic pressure of both classes of colloids be taken, the important fact is brought to light that it is very small and in fact at times too minute for actual observation, whereas, true solutions such as cane sugar solution, etc., have very large pressures. The following table brings out these facts very strikingly.

Substance.	Concentration %.	Osmotic Pressure cm. Hg.
Cane Sugar	1.0	53.0
Cane Sugar	5.0	265.0
Gum Arabic	1.0	6.9
As_2S_3	4.0	1.7
Ferric Hydroxide	1.1	0.8
Ferric Hydroxide	2.0	2.8
Ferric Hydroxide	8.9	22.6

(c) As already noted in the introduction, colloids show practically no diffusive power through certain membranes, whereas, crystalloids pass through them very readily. It was this observation which led Graham to the conclusion that the size of the colloidal particles must be enormous, and therefore they could not pass through the small pores of such membranes, and led him to assign also a very great molecular weight to them as has already been stated. Upon this property of colloids, their slight diffusion, depends their separation in solution from ordinary crystalloids. If, then, such a mixture is placed in a collodion dialyzer[1] and the

[1] NOTE.—Among the many forms of dialyzers in use at the present time, the "parchment-paper" dialyzer is usually recommended as most suitable for dialysis. I have found it faulty in the following respects: First, the available dialyzing surface is small, and secondly, if large, the single

whole placed in running water, the crystalloid will soon pass out of solution, the water passing in either direction, while the colloid will be retained in the vessel, called the dialyzer. This process is known as dialysis, and it was extensively used by Graham in his many researches upon the properties of colloidal preparations.

(2) *Opalescence.*

A general property of colloidal mixtures applying to both the natural and the prepared, is that they appear opalescent by reflected light. Collodial arsenious sulphide and colloidal ferric hydroxide (when not too concentrated) will show this very conclusively. The true cause of opalescence is still a matter of dispute. Scientists differ widely in their statements.

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covering under pressure breaks, after a short exposure to running water. It can be used to advantage only when the proper kind of paper is available, and then the conditions for such are difficult to obtain.

I have found the "collodion dialyzer" very convenient and besides its durability (being able to remain intact for considerable time in running water) it offers a much greater freedom for dialysis and therefore less time in which to complete the process. Directions for the preparation of such a dialyzer can be found in special articles, and they are therefore given for the sake of convenience and ready reference.

A few cubic centimeters of collodion are placed into a dry and clean four-ounce bottle having a wide neck. The bottle is then revolved horizontally spreading a uniform coating of collodion over the inside. The remaining collodion is poured back while rotating the neck of the small bottle. This process will insure a uniform coating. Working rapidly will prevent too thick a covering, which is to be avoided, thus preventing ultimate cracking of the collodion. When the proper coating is obtained, the bottle is then inverted and given a rotary motion between the palms of the hands. This causes evaporation of the ether which is hastened by blowing into the bottle. When all the ether has evaporated, water is poured into the bottle which will dissolve out the alcohol. (Collodion is a solution of guncotton in ether and alcohol.)

The film of collodion around the neck is then carefully detached, and a little water added between the neck of the bottle and the film. With a gentle, prying motion the water works its way around and loosens the collodion which can then be taken out of the bottle.

The solution is placed in the dialyzer thus prepared, a rubber stopper inserted in its neck, then attached to a clamp, placed in a jar of running water, and the whole apparatus is ready for dialysis.

Very useful dialyzers can be conveniently made by using small test-tubes of about 35 c.c. capacity as moulds, by following the above directions. I have found them to work extremely well. The liquid can be placed in these dialyzers and a space of about an inch left for the increase in volume of the liquid caused by the entrance of the outside water. The top is then closed tightly with a piece of cotton thread and placed in a large vessel of running water. These small "sausage collodion" dialyzers float around while the liquid dialyzes very quickly. In this manner, large amounts of liquid can be dialyzed at one operation and in one vessel.

(3) *Reversible and Irreversible Colloids.*

A striking difference between the two classes lies in their behavior towards heat and cold. If gelatine, albumen, agar-agar, gum arabic, etc., are heated, they form viscous liquids which on cooling return to their original solid condition and can again go through the same changes. Such colloids are said to be *reversible,* and this property is characteristic of all natural colloids.

Colloidal ferric hydroxide, colloidal arsenious sulphide, do not undergo such changes. If they are cooled no precipitation or coagulation takes place, and if coagulated, heating has no effect in bringing them back to their original condition.

Such colloids are called *irreversible.* This property is true of most of the prepared colloids.

(4) *Mutual Hindrance.*

Again, colloids mutually prevent each other's passage, while they allow the passage of crystalloids very readily. Thus, if a 4% solution of agar-agar be prepared, by dissolving 4 grams of the substance to every 100 cc. of boiling distilled water, and the resulting solution be poured into two large test-tubes tightly corked and then allowed to cool, a true natural colloid is obtained having the appearance of a jelly. If, then, one of the sticks thus prepared be immersed in an ammoniacal copper sulphate solution (prepared by adding strong ammonia water to the copper sulphate until the precipitate first formed just dissolves) and allowed to stand over night, it will then be found on cutting the sticks in two that the deep blue color has permeated the agar-agar uniformly to the center, imparting to the stick a deep blue color. On the other hand if the second stick be placed in any other colloid (preferably one that is highly colored) and allowed to stand the same amount of time and the stick is then cut open, no color will be found to have permeated it. Thus, agar-agar, a true natural colloid, has allowed the passage of a crystalloid while it prevented that of the colloid. The properties enumerated are only a few of the many that could be cited; but the most striking, characteristic in general of this great class of substances, have been given.

Electrical Phenomena.

Perhaps the most interesting of all the properties of colloids is that they appear to be charged electrically and exhibit under

certain conditions electrical phenomena. This can be shown in a number of ways.

(1) *Migration.*

If an electric current is passed through colloidal ferric hydroxide and also through colloidal arsenious sulphide, contained in separate *U* tubes, one side of which contains the anode and the other the cathode, after a lapse of a few minutes migration will take place towards definite poles from which we argue that the colloidal particles are electrically charged. It will be found that in the former colloid, ferric hydroxide, migration takes place towards the cathode or negative electrode, and that therefore colloidal ferric hydroxide must have on it a positive charge; while colloidal arsenious sulphide will be found to move towards the anode or positive electrode, and is therefore negatively charged. It would be profitable to point out here that both the ferric hydroxide and arsenious sulphide (in colloidal form) move as an ion, the former as a positive ion, the latter as a negative one.

Before the current is turned on, the liquids appear perfectly homogeneous and as clear as solutions, having their characteristic opalescence. Just as soon as the current passes, the colloids not only begin to migrate, but they are precipitated around the electrodes as shown by characteristic colors which they assume, and they lose their opalescence.

The same is true of other colloids. Metallic hydroxides, silicic acid, basic dyes, as methyl violet, methylene blue, etc., are all charged positively and migrate to the cathode, while all metals, metallic sulphides, starch, acid, dyes, as aniline blue, indigo, fuchsin, etc., are all charged negatively and migrate to the anode. The natural colloids do not show this effect for they do not migrate when a current is passed through them, and they are therefore devoid of any charge whatsoever. It is for this reason that the addition of a electrolyte fails to produce any coagulation as will be pointed out later.

(2) *Change of Charge.*

Not only do colloids have definite electrical charges on them, but the character of the charge may vary with conditions. Thus colloidal platinum is negative in a medium such as water, but acquires a positive charge when prepared in a mixture of water and alcohol. Again, albumen, colloidal silicic acid, and colloidal stannic acid are negative in alkaline liquids and positive in those which are acid.

(3) *Coagulation.*

The use of the electric current is not the only source for demonstrating the electrical nature of colloids. Electrolytes, or highly ionized substances, will show the same behavior in discharging the colloids, and in ultimately precipitating them.

(1) *Electrolytes:* If to some colloidal ferric hydroxide or arsenious sulphide we add an electrolyte such as sodium chloride, NaCl, it will be found that the colloid is fairly rapidly precipitated when a sufficient amount of the salt is added. If, however, the same amount of sulphuric acid, H_2SO_4, is added, almost immediate precipitation or coagulation takes place. The coagulation of the colloid will depend upon its charge and also that of the ions. Again, the increased speed of coagulation has been found to vary with the valency of the ion of opposite sign to the colloid and therefore sulphuric acid, valency of two, is a better reagent than sodium chloride, whose ions are only univalent. Trivalent ions will in turn be more effective in producing the desired result. Concentration also plays its role in this instance, for a definite concentration of the free ion is necessary to produce *complete* coagulation.

If separate 50 cc. portions of arsenious sulphide, in the colloidal condition, are poured into several large test-tubes, and 200 cc. of the following concentrations of the electrolytes in milli-equivalents per litre are used (non-electrolytes have no effect even if present in great concentration), as shown by the number preceding the electrolyte, immediate precipitation takes place with those having a dot prefixed, while the others will show less activity. It can be also readily shown that colloidal ferric hydroxide behaves in a similar manner.

Colloidal As_2S_3.	Colloidal $Fe(OH)_3$.
. (1) 0.6 $AlCl_3$	(1) 0.02 $K_3Fe(CN)_6$
(2) 1.5 $MgCl_2$	. (2) 0.1 $K_3Fe(CN)_6$
. (3) 20 $MgCl_2$	(3) 0.1 Na_2SO_4
(4) 60 NaCl	. (4) 1.6 Na_2SO_4
. (5) 400 NaCl	(5) 6 NaCl
(6) 60 Na_2SO_4	. (6) 50 NaCl
. (7) 400 Na_2SO_4	(7) 5 $MgCl_2$
	. (8) 50 $MgCl_2$

(2) *Mutual Colloidal Coagulation:* Still another method of coagulation depends upon the mutual neutralization of the charge on one colloid by that on the other. If colloidal ferric hydroxide be added to colloidal arsenious sulphide both will be immediately

precipitated. In short, colloids bearing opposite charges will mutually coagulate each other.

When gold chloride is added to stannous chloride, a purple precipitate of colloidal gold particles which contains a negative charge, is formed, and this can be precipitated by colloidal stannic acid (carrying a positive charge) in the presence of HCl. If to this precipitate, an alkaline solution of ammonium hydroxide is added, the stannic acid now acquires a negative charge, is like the colloidal gold, the precipitate dissolves, and forms the beautiful tints of colloidal gold suspensions.

This negative solution is now extremely sensitive to the ions of a mixture of ammonium and magnesium nitrates.

(3) *Protective Colloids:* The point must be emphasized here that certain colloids, natural colloids, of the albumen type, may entirely prevent the coagulation of a colloid if present with the precipitating electrolyte; that is, when 200 cc. of a 0.05 Molar silver nitrate, $AgNO_3$ solution containing 2.5% HNO_3 (S. G. 1.42) is mixed with a 0.05 Molar sodium chloride NaCl, solution, a white precipitate of silver chloride AgCl, immediately separates, but if repeated with 1% gelatine solution a white opalescence appears, and no precipitate separates even on prolonged standing. If hydrogen sulphide H_2S (containing no traces of electrolytes) is added, a black colloidal insoluble precipitate of AgS, silver sulphide, is formed which will not settle on prolonged boiling or standing.

Theories on Colloids.

We have so far in our discussion concerned ourselves with certain properties peculiar and characteristic of colloids, without attempting to offer any explanation, and it remains to do so now.

As is true of a great many natural phenomena, so here no one explanation of their singular behavior can wholly suffice, though from time to time, many have been attempted with more or less success. Of all such attempts to explain their electrical charge, two deserve our special attention here, namely, that of Surface Contact and Ionization.

(1) *Surface Contact.*

We have first, a case of surface contact or surface electricity. It has been proven by experiment, that at the surface of two different substances there is always a potential difference and in the case of colloidal suspensions, there is a large surface contact, as compared with the surfaces exposed in ordinary cases of contact. A colloid like platinum or gold is negatively charged, and

the bathing medium receives the positive charge. This we have shown takes place when the medium is only water. Now, it was stated that colloidal platinum in water and alcohol is oppositely charged, positively, and according to this theory the bathing medium would then receive the negative charge. In the case of colloidal ferric hydroxide, positively charged, the bathing medium becomes negatively charged. Plausible as this explanation might seem, it still does not tell us which charge will be taken up by the colloid and which by the surrounding medium, and therefore the other theory which makes it a case of ionization seems to answer the question more conclusively.

(2) *Ionization.*

As a phenomenon of ionization, let us take colloidal ferric hydroxide as an example. This may dissociate and send a few hydroxyl ions into solution and leave a residual positively charged colloidal particle. With stannic acid or silicic acid, hydrogen ion would be sent into solution (positively charged) and leave behind a residual negatively charged colloidal particle.

Now, albumen is capable of forming salts, both with acids and with bases. As a salt, it would dissociate into ordinary positive ions and a colloidal negative one in alkaline solution and into an ordinary negative ion and positive colloidal one in acid solution, in harmony with the above theory.

But how are we to explain the action of the metallic colloids since metals cannot undergo ionization? To answer this question it is necessary here to make one further assumption. The surrounding medium ionizes, imparts the charge to the metal and causes it to assume the colloidal state. In a medium such as water its ionization charges the noble metals negatively.

The source of electrical charge must therefore be due to partial ionization and not to total ionization. That is, if the ferric hydroxide ionized totally, then it would send positive iron ions into solution and negative hydroxyl (OH) ions into solution and it would give rise to a simple case of ionization of an electrolyte. But the current does not throw out iron at the cathode nor (OH) at the anode, but red gelatinous ferric hydroxide is coagulated en masse at the cathode. It is therefore evident that by sending a few OH ions (negatively charged) into solution it leaves the opposite positive charge on the colloid as demanded by this theory of partial ionization.

Concluding our brief remarks we must say that no definite knowledge has as yet been obtained as to whether contact or a case

of partial ionization, is the correct view. At present, experimental evidence is hard to obtain, and time bringing better methods for research may decide definitely in our favor.

Solution and Suspension.

Having noted the fact that colloidal solutions give very low osmotic pressures, little lowering of the freezing point and but small increase of the boiling point, and also only slight variations in vapor pressure, while true solutions such as cane sugar solution or one of copper sulphate give very high osmotic pressures and so forth, it becomes necessary to investigate whether these colloids are true solutions or simply cases of finely suspended particles of matter.

Before attempting in the face of contradictory and much disputed opinions, an explanation of such vast importance to chemistry, it will be advisable to review the more salient points gathered by experiment and observation, which may throw light upon this phase of the subject.

First, a very powerful microscope, known as an ultra-microscope (that is beyond the power of an ordinary one) through which has been passed a very powerful and strongly illuminated beam of white light, which has previously passed a colloid, will reveal the presence of finely divided particles seemingly in a suspension. Not only does this microscope reveal these suspended particles, but a peculiar vibratory motion of the particles, which dart across the field of vision with more or less speed depending upon their size, can also be seen. The larger particles are seen to move very slowly in comparison with the smaller ones. This peculiar movement is known as the "Brownian Movement" after Professor Brown, its discoverer. It is probably caused by internal heat. Another view held by many scientists is that the tendency to move downwards by the action of gravity, and the viscosity of the surrounding medium to retain the particles in suspension, produce a sort of "see-saw" effect, an up and down motion. Should one of the factors, viscosity or gravity, gain the upper hand, then the particles will remain suspended or settle out. This takes place in a case of precipitation, where the particles become great enough to be influenced by the action of gravity and settle out. Should viscosity gain the upper hand, then the particles rise to the surface sometimes in the form of a fine scum. True solutions do not show this peculiar behavior, and we are therefore, in the case of colloids, not dealing with true solutions.

Again, when a beam of light is passed through any medium containing suspended particles, the beam becomes visible as does a sunbeam in dusty air, causing diffuse reflection of the light. Not only this, but the light becomes polarized and can be made to give a dark field when viewed through a polarizer or Nicol prism. This can be shown to be the case with colloidal arsenions sulphide, colloidal ferric hydroxide, but true solutions show no such behavior and again proves the colloid to be different from them.

Homogeneity.

It appears from investigations of colloids as to the degree of divisibility of their suspended particles, that all solutions must be considered as suspensions of their dissolved particles, and that homogeneity, a characteristic of all true solutions, is also simply a case of suspension in which the particles are so finely divided that they can not be detected by our present optical methods. The size of such a particle would fall with the limits of 0.1 $\mu\mu$ in diameter (1μ equals 0.001 mm.), the calculated limit of molecular divisibility. Granting this as the extreme limit of divisibility for particles in true solution, colloidal solutions must be those that lie somewhere between this extreme limit (0.1 $\mu\mu$) and some greater limit, that is 20 $\mu\mu$. Such a colloidal particle then becomes visible under the ultramicroscope, but is still invisible to the naked eye, or under the ordinary microscope. Should, however, the divisibility approach the value 1 μ, then the suspended particles become visible under the microscope and we have a case of ordinary coarse suspension. From this rough classification it would follow that colloids are simply suspensions whose particles lie somewhere between the above limits, 0.1 $\mu\mu$ for true solutions and 1 μ for ordinary suspensions.

From the above remarks, homogeneity, a characteristic of true solutions, and heterogeneity, that of colloidal solutions, must be due especially to the extreme divisibility of their suspended particles and the discussion would therefore resolve itself around the heterogeneity of solutions in general.

In conclusion, let it be stated that the field of the investigation of the properties of colloids offers enormous opportunities. Whether colloids are true solutions or not, whether they are homogeneous or heterogeneous only time will tell, thus terminating the present necessity for involved and hairsplitting distinctions. Here, however, is a field, teeming with a harvest of truth, which must ultimately yield to the implements of industrious application and research.

SUGGESTIONS FOR THE PROSPECTIVE MATHEMATICIAN.

By G. A. Miller,
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The rapid mathematical advances during the last few decades have effected a great change as regards the qualifications of mathematical leaders. In the days when no mathematical societies existed, the local reputation of a mathematician practically determined his standing. As the departments were very small this generally meant that a man obtained his standing by his reputation among his students and his non-mathematical colleagues.

This reputation is still very important and it will probably always be a strong factor in fixing the influence of a mathematician, but the mathematical societies and the mathematical reviews have introduced another factor which is becoming more and more prominent. This factor is largely based on very different qualifications. A modern mathematical leader must be helpful to those who have extensive knowledge along certain mathematical lines. He must do his part towards extending our knowledge in certain important fields, and he must know these fields not merely on the surface, but also below the surface.

This implies that he must dig, and dig deeper than the average. It is still more important that he should choose wisely as regards the place where he will do his work. A place that has been dug over a dozen times is not apt to yield much that is new. Hence the modern mathematician must know some things about unexplored fields of mathematics, and this implies considerable knowledge as regards what has been explored thoroughly.

As mathematics is cosmopolitan, the modern mathematician must know enough about the languages of the most active workers to understand readily their accounts of their work and of their discoveries. During the last century, and at the present time, the most of the successful mathematical work has been and is being done by people who use the following four languages: French, German, Italian and English. Hence the modern mathematical leader must have at least a reading knowledge of each of these languages.

In recent years changes have been made in many American universities which call for additional caution on the part of the prospective mathematician. I refer to the increase in the number of scholarships and fellowships. These offer greater oppor-

tunities and doubtless tend towards higher scholarship and towards higher attainment on the part of the leaders. Hence the prospective mathematician should aim at a more comprehensive knowledge of his subject than that possessed by those who are now in active service. The rapid improvements in the facilities for work make this feasible.

A young man can scarcely expect to achieve success as a mathematician unless he is so deeply interested in mathematics that his work along this line gives him genuine pleasure. He should not confine his reading to this line, but when he reads for pleasure or desires something that is unusually interesting he ought to turn to mathematics. Without such a deep and abiding interest he cannot hope to keep up with the pace of those who are thus interested, and he should either turn his attention to some other field or be contented with mediocrity.

While mathematical reading is very necessary for the prospective mathematician it is not the main thing. The main thing is mathematical thinking. The fact that the mathematician deals mainly with necessary conclusions from given postulates or theorems[1] makes this thinking effective and final. We should read to think and not think to read. That is, our reading should be primarily with a view to aid our thinking and not to acquire new facts, except as regards what has been done and what has not been done.

We need only one language to think but we unfortunately need several languages to read all that is known about a particular subject. Hence it results that although reading is a matter of secondary importance to the prospective mathematicians, it calls for the extensive linguistic studies which absorb much of his time and energy. These studies should be undertaken as early as possible so as to allow more time for thinking at the age when this faculty becomes really effective.

The prospective mathematician cannot be urged too strongly to read the writings of some of the most successful investigators and to seek courses under such men. As he is reading and following courses with the object of learning how to think most effectively, and as he should not accept any mathematical statement unless he has proved it and made it fit into his own store of knowledge, it is clear that he should seek the best models of thought. Those who have succeeded as investigators and those

[1]In accord with a commonly accepted definition, all mathematics deals with necessary conclusions. On the contrary, the formalists in the theory of aggregates seem compelled to admit contradictory results as mathematical.

who are succeeding now are likely to furnish these models. This fact needs especial emphasis in our day, since scholarships and fellowships in our universities, and the desire to get a degree as soon as possible, frequently tend to put the graduate student too completely into the hands of the mediocre.

As teachers we should bear in mind that the most glorious thing that can grace our careers is finding and directing wisely some future leaders. Wise and courageous leaders can do a vast amount of good and are always needed. If we find in our classes a young man who has the ability and inclination to succeed as a mathematical leader, it is certainly a great privilege to be instrumental in starting him correctly. Hence it is a duty of the high school and the college teachers to know how to direct the reading of such a young man and where he should go after he leaves our classes.

In choosing a university it should be remembered that departments are frequently very unequal in the same institution. It sometimes happens that a very strong university has several very weak departments, while these departments may be much stronger in some weaker institution. The exceptional student has a right to expect some good advice from his teachers along these lines, and hence the latter should aim to be informed as regards such difficult and somewhat delicate questions. Such works as "American Men of Science" are very useful along this line, but these works should be supplemented by more recent information in view of the fact that conditions often change rapidly.

In these days of statistics, averages, and norms, let us not forget the abnormally good students, and the great services such students can render under favorable conditions. It is true that these students are very few but they should not escape our attention, and, if they appear in our classes, they deserve a proportionally larger part of our time than the average student, in view of the fact that they are likely to render more important service. In fact, they should inspire us with new life and enthusiasm, and hence repay us and their fellow students directly for the extra time and thought bestowed on them.

In particular, the student who shows unusual mathematical ability should be encouraged to seek and to give proofs which differ from those in the text, to generalize the questions under consideration, and to read works where the questions in hand are treated from a more general standpoint. It is also important

to secure early a knowledge of subjects to which mathematics can readily be applied, for the connections and interrelations of different sciences should enter prominently into the thinking of all those who desire to render efficient service in advancing scientific knowledge.

It is generally admitted that America is a comparatively new country mathematically and offers many of the advantages and disadvantages of frontier life along this line. The prospective mathematician may therefore reasonably expect to find numerous opportunities to render effective service during the changes for the better which are bound to come. Such changes call for unusual alertness and they are apt to be attended by rapid changes in leadership along certain lines. The prospective mathematician has therefore reasons to believe that his opportunities will be abundant to render service of the highest order in the further development of this subject, and this should constitute an additional inducement to aim at the best possible preparation.

Such a preparation implies that strong independence and self-reliance which is based upon a masterly comprehension of the situation. The student needs to cultivate the important faculty of seeking advice at the right place, and of weighing all such advice even if it comes from an excellent scource. The best friend cannot so fully comprehend our own limitations and strength as we do ourselves, nor can he have considered so fully our individual aims and desires as we ought to have considered them ourselves.

The preparation noted above is, in general, the minimum common preparation of all prominent mathematicians at the present time. In particular, it is essential to have a reading knowledge of French, German, English and Italian; but, it is impossible to enter deeply into many historical questions without possessing also a good reading knowledge of Latin and Greek, and it is not possible to follow closely the present advances in mathematics made by some of our close neighbors without a reading knowledge of Spanish. A few years ago a Spanish mathematical society was organized, and this society is now publishing, in Spanish, an interesting elementary mathematical journal entitled "Revista de la Sociedad Matemática Española." The address of the society is San Bernado, 51, Madrid, Spain.

The prospective mathematician should aim to excel all others along some line, but he cannot afford to neglect that broad training upon which scholarly comradeship is based. With the widen-

ing of the developments of mathematics comes a greater variety of choices as regards the field in which the mathematician may strive to excel. Even along the line of criticism some useful work can be done, since some authors need the fear of adverse criticism, otherwise they would continue to repeat gross errors which hinder true advances.

The fact that our country has still too little of scholarly criticism along mathematical lines has recently been emphasized by the appearance of Funk and Wagnalls's "New Standard Dictionary of the English Language," 1913.[2] It is not to be expected that such a general work would include definitions of the less common technical terms used in mathematics, but those terms that are defined should be defined correctly.

Many incorrect definitions of mathematical terms appear in the dictionary under consideration. Some of these may have been due to carelessness. For instance, the statement under ***dimensions*** that "four-dimensional space may be regarded as a hypothetical conception to explain equations of the fourth degree in analytic geometry." If we replace "equations of the fourth degree" by "equations involving four variables" this statement conveys a meaning.

On the other hand, some of the mathematical definitions in this valuable dictionary seem to imply complete ignorance of the meaning of the term on the part of the author of the definition. An instance of this kind appears under the term *group,* where a regular group is defined as a "transitive group whose order is the same as that of the letter on which it is made." In the first place, a regular group is not made on a letter, and, in the second place, a letter does not have an order in this theory. In fact, the given definition seems to imply a wild guess and it does not convey any meaning even to those who are familiar with the theory of regular groups.

In directing attention to the field of mathematical criticism it is not implied that this is one of the most useful fields for the prospective mathematician. Constructive work is generally more important. The reference may serve to emphasize the wide field of usefulness for the prospective mathematician, and also to give wider publicity to the fact that mathematical terms in some of our standard works of reference have not received due attention, in the hope that such publicity will tend towards an improvement along this line.

[2]A brief list of incorrect mathematical definitions appearing in this dictionary was published in *Science*, Nov. 28, 1913, p. 772.

NEEDED: A FUNERAL OF ALGEBRAIC PHRASEOLOGY.

By Effie Graham,
High School, Topeka, Kansas.

This is not an "article." It is but an overflow from the full heart of an algebra teacher who lays down her chalk and takes up her typewriter for two reasons: First, she can keep still no longer, and, second, she hopes that enough of her fellow sufferers among the $x\ y\ z$ teachers, may agree with her, so that by uniting we may "do something," the culminating excuse for all American Town Meetings.

This is a call for aid in crucifying, or casting out from our algebras where they will be forever powerless to do us further harm, our ancient enemies, the old phrases—"clearing of fractions," "cancellation," with all their kith and kin; not forgetting that rank old say-nothing, "Mr. Simplifying," and the meaningless or rather wrong meaningful "*a* into *b*," and "*a* over *b*," with all the rest of the misleading terms with which we clutter the consciousness of the first term algebra student.

These phrases are easy of speech, go "trippingly upon the tongue," and appeal to the half acknowledged wish on the part of the freshman to speak the high-school language, no matter whether he understands it or not. He parades these phrases as he does the abbreviations "gym.," "lab."' and "trig." He rolls them under his tongue as he might the password of a secret society, than which there is nothing more dear at this time of his life. He is caught also by processes, by acts. Many of our freshmen are still in the action stage of their development and processes are sufficient, reason below par.

And so some of us allow the use of all these wrong verbs and rejoice in the skill with which our pupils "clear, transpose, extract, and remove," forgetting that these are mechanical actions and not mathematical processes at all; and that, explain it ever so well, there are probably many members of our classes who wait with half concealed impatience, "till she got done and would show us how to DO 'EM. . . . I've got six. How many you got?" . . . and then go merrily on "clearing" as they would the dinner table, and "removing" as they might a stone from the street, purely mechanical, machine-like processes.

But wait a year or two, good teacher! Visit a class in higher or college algebra, when our prize "transposer" has reached the stage in mental development where memory ceases to rule;

when action is replaced by reason, the "why" instead of the "how" stage, and notice what happens. See this student solemnly solve for a in the equation $ab = c$, by writing with calm criminality $a = c - b$. See him derive from $\sin^2 x + \cos^2 x = 1$, the fatal falsehood, $\sin^2 x = \frac{1}{\cos^2 x}$; and weep with me when our star pupil, confronted with a complicated fractional reduction, calmly and with smug satisfaction, throws away the denominator as he might fling away a match. When you ask meekly, why he does that, he answers with unquickened sense of shame, "Oh, I always forget when to *discard* the denominator." Shades of Hoyle!! Is this a card game?

"What do you mean by '*extracting the root?*'" asked a high-school girl one day after the teacher's appeal for mental honesty and a refusal to use half-understood phrases. "Why is it called *extractin' a root?* Do you know what I always think of when I hear that?" she went on, "a dentist's chair and how it hurts to have 'em extracted." Next time the teacher knew.

What to do? This is no new story. It is as old as SCHOOL SCIENCE AND MATHEMATICS. Your writer knows that fact well. She knows, too, that many apostles of better algebra have long ago told how. It is only for the sake of refreshing your memories that she repeats it here. What to do? First, let us have a text in which these objectionable expressions do not occur. No, not even in the appendix to show that the author really knew them once. Banish them from the books. Find a book or make one that shall say "multiplying," "dividing," "adding," "subtracting," when necessary. These are the only mathematical processes worth while and our pupils must be taught to call these by their right names. They must be taught first, how to "perform" these processes. Pardon the term. This is not a circus. Then they must be taught that all algebra is but the application of these four processes. Teach them that in solving the equation $x - 2 = 3$, the 2 does not lost its minus sign like an outgrown organ when it crosses equality, turning up with a plus that it surreptitiously acquired in transit. Show instead with colored crayon maybe that the 2 which really appears on the right is not the old 2, but one that we ourselves added to the equation.

Teach them that "extracting the square root" is not a task for a dentist, but is only finding one of two equal factors. Our pupils must be obliged to multiply each term of an equation by the L. C. D. at first; then they will not speak of "dropping" the denominator as if it were a hot cake.

Bury forever that old Latin word cancellation.

"Sometimes it means to add and sometimes it means to divide. How do you know?" said a little freshman.

Put into the same grave also that omnibus misnomer old "simplify," meaning everything and nothing. Say plainly and constantly "multiply, divide, add, or subtract" and oblige your pupils to do the same. Then, when memory has served its purpose, when facts fail the youngsters, and reason is seeking her own there will remain only the work fit for reason, that is to find out when to add, when to multiply, and so on.

Much would be the gain in our school mathematics. Much the gain in honest speech which scorns the false and meaningless. Much the gain in the pupil's ability to find himself when lost in an algebraic maze, without the aid of the prompting teacher who should at this time be most properly "cancelled out" of the expression; thus allowing our pupil the pleasure and profit of independent school effort as a slight preparation for the world's equation which he must solve alone.

COLORED CRAYONS AS AN AID IN TEACHING MATHEMATICS.

By Ada M. Parsons,

Milwaukee West Division High School.

In teaching geometry, one of the articles in the "first aid to the weak" box of devices should be a few colored crayons. A great variety is unnecessary; but a few that show clearly on the blackboard are of assistance in illuminating the darkness in which some minds seem to grope when a lesson in geometry is under discussion.

The use of these crayons is varied, and new applications suggest themselves each year—some to be rejected because they involve too complicated elaborations, and others to be kept in mind ready for the emergencies which they fit.

One of the first applications comes in the theorems proving the congruity of two triangles by making them coincide. If each part of one triangle is colored when it has been definitely proved that the corresponding part of the other has been made to coincide with it, fewer pupils will make one line fall upon another because "the two lines are equal," and various other steps are made clearer.

In the application of the propositions concerning congruity of triangles to succeeding propositions and to originals, giving the same color to the lines or angles which are known to be equal enables the beginner to see which combination he has and whether or not it is sufficient for his purpose. For instance, in the proposition, "The angles opposite the equal sides of an isosceles triangle are equal," the two legs might be colored blue, the construction line bisecting the vertex angle yellow, and the halves of the vertex angle red. Result—the eye sees the two sides and the included angle in each triangle. After this the selection of homologous parts as those opposite like colored sides or angles is a comparatively simple matter, even if the triangles are not arranged in similar positions on the page or board.

The distinction between a theorem and its converse may be shown vividly by coloring each figure with one color for the hypothesis and another for the conclusion. Thus in the theorem previously quoted and its converse, if it is agreed that the parts which are given equal by hypothesis are to be colored blue while those of the conclusion are red, in the one case there will be shown the blue legs and the red angles at the base, while in the other figure the colors will be reversed.

In working with locus problems our colored crayons are invaluable. If the student learns at first to put in the locus in color, it gives definiteness to his otherwise hazy idea of the use of the word. In a problem whose solution demands the intersection of two loci he sees that every point in the blue locus satisfies certain of the conditions, and that every point in the red locus satisfies other conditions. A point, therefore, which is both blue and red must satisfy all the conditions under which the two loci were constructed.

There is a wide divergence of opinion as to the advisability of introducing the pupil to the dread "theory of limits" in his high school course in geometry. Many of us believe that there is enough of value in it for our pupils to warrant our spending a little time on it. Colored crayons are of great assistance here, for instance, in the demonstration of the theorem "Two circumferences have the same ratio as their radii." After the preliminary work has been done, and variables have been created by the magic words, "Continuously double the number of sides of the inscribed polygons," the letters which represent variables are put down in color, while the constants are white. The fact that the ratio P : R is a variable is emphasized by drawing a colored

ring about it, thus enabling the student to find that "the two variables which are always equal" are ratios, and that as a result of their equality the two constant limiting ratios are equal.

These are a few of the ways of using colored crayons in geometry. In algebra their application is more limited, but occasionally they are of use here. An instance of this is in the solution of literal equations, especially where some letter other than x represents the variable. If the variable appears in a colored costume, there is less danger of a solution in which it appears in the result.

All these, of course, are devices by means of which the pupil's imagination may be quickened so that he may learn to work without any such aids to the eye. They also serve as a quick test of his mastery of these points. Frequently when the crayons are placed in his hands he shows by his use of them that he thoroughly understands a demonstration, or else he enables the teacher to see exactly where his difficulty lies.

When the colored crayons are brought out, the bright student looks up with interest to see what new use is to be made of them, and the slow one is alert in the hope, often fulfilled, that the way will be made clearer to him, so that he may take another step forward in the mastery of the subject.

LITTLE COAL AND OIL DEVELOPMENT IN ALASKA.

Alaska coal fields continue to be undeveloped, according to the United States Geological Survey. The only coal being mined is some lignite coal taken out for local use at Cook Inlet, on Seward Peninsula, and at several other localities. The total production in 1912 did not exceed 100 or 200 tons.

One oil company continued operations in the Katalla petroleum field in 1912, as in 1911. One of the two producing wells is said to have been sunk to a depth of about 800 feet. The oil is procured by pumping and is refined in a small plant located near Katalla, and the gasoline finds a ready sale in the coastal setttlements of this part of Alaska. There are several other oil companies which control property in this field, but these seem to have done little in the way of development during 1912.

THE GLOW-LIGHT OSCILLOGRAPH.[1]

By P. M. Dysart,
Pittsburgh Central High School.

All teachers of physics—I presume—very much desire to have a Duddell oscillograph in their possession, but no doubt, most of us, like myself, have not yet mustered up sufficient courage to ask our boards of education to appropriate the considerable sum needed for the purchase of one. However, the glow-light, or Gehrcke-Ruhmer, oscillograph is a fairly satisfactory substitute for the true oscillograph, and its cost is so small, between ten and fifteen dollars, that its purchase is possible for every one of us.

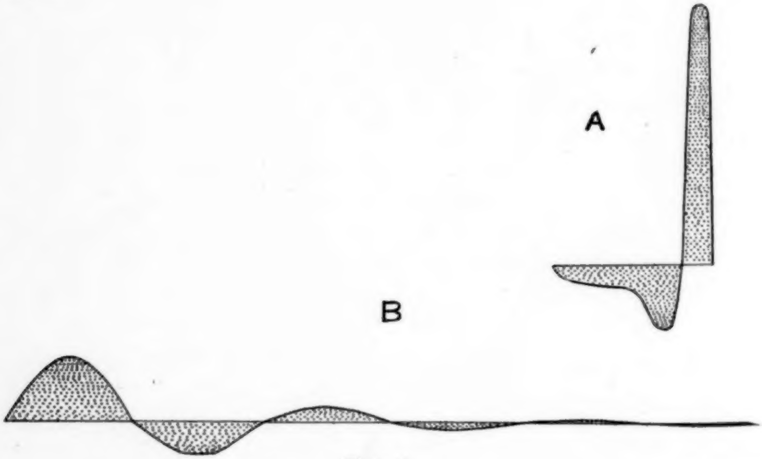


Fig. 1.

The instrument, shown in Figure 1, A, consists of a cylindrical glass vacuum-tube provided with two electrodes of aluminium wire. The diameter of the wire is about one millimeter. The electrodes extend along the axis of the tube towards the center. They come quite close together at the center of the tube, being separated by a space of about a millimeter and a half. Our tube, which was purchased from Max Kohl, Chemnitz, Saxony, is about thirty-five centimeters long and four centimeters in diameter. Though a potential difference of about 1000 volts will cause the electrodes of the tube to glow, it is well to use a transformer giving several thousand volts; for a high resistance must be placed in series with the oscillograph. This

[1]A brief discussion of the theory of the glow-light oscillograph is given in F. Parkman Coffin's article on the Physical Phenomena of the Mercury Arc Rectifier published in the October, 1913, number of the General Electric Review of Schenectady, New York.

is done in order to prevent a strong current from flowing through the tube, thus injuring or destroying it. I found it convenient to use an oil-immersed induction coil as a step-up transformer. As is shown in Figure 2, B, the primary of the step-up transformer was supplied with alternating current through an auto-transformer having a range of 10 to 110 volts in steps of 10 volts. As a rule, the auto-transformer was so adjusted as to make the potential difference of the terminals of the secondary of the step-up transformer about 5000 volts. The water rheostat was made of two glass tubes, each about sixty centimeters long and three centimeters in internal diameter. These tubes were filled with distilled water and provided with terminals so arranged that the tubes could readily be connected in series, or in parallel, or used separately.

Let us suppose that the apparatus is connected and that the potential difference applied to the oscillograph is of such a value that the cathode glow appears to extend along each electrode for a distance of one centimeter. In reality there is a glow upon a given electrode only while it is the cathode. The distance that the glow extends along the electrode is a function of the instantaneous value of the potential of the electrode; therefore it is only at the maximum of the potential wave that the glow extends so far as one centimeter. Assuming that the alternating wave is of pure sine form and that the distance along the electrode that the glow extends is directly proportional to the potential; at 22½ electrical degrees, the glow extends .38 centimeter, at 45 degrees, .71 centimeter, at 67½ degrees, .92 centimeter, at 90 degrees, 1.00 centimeter. Between 90 and 180 degrees the distance decreases at the same rate as it increased between 0 and 90 degrees. Beyond 180 degrees the glow leaves the first electrode, which we may assume to be the upper one, appears upon the lower one and there changes in length according to the same law. Absolutely instantaneous photographs of the electrodes, taken at proper intervals, would present the appearance shown in Figure 2, C. Unless the tube be supplied from a very low-frequency alternating current generator, of lower frequency than any machine in commercial use, persistence of vision causes the glow on each of the electrodes to appear to be continuous. It is, therefore, necessary to view the electrodes in a rotating mirror. In order to obtain the best results, the mirror should be driven by a synchronous motor fed from the source that supplies the tube. I have, however, obtained very

satisfactory results by using a direct current motor provided with a speed-regulating device that changes the speed by very small steps. The angular speed of the mirror should bear an integral relation to the frequency of the alternating potential applied to the tube. For example; if there be 7200 alternations per minute, the mirror may make 180 or 360 .... turns per minute, but not 170 or 380 ..... In the first case the wave forms as a whole will appear to be stationary; in the second case in which the speed is too low, the whole series will appear to move rapidly toward the right or left, as the case may be; in the third case in which the speed is too high, the apparent motion will be in the opposite direction. A small departure from the integral relation, as 361 instead of 360 turns, causes a slow motion of the series, too slow materially to weaken the effect of the demonstration.

Figure 2, D is a sketch of the wave form seen in the rotating

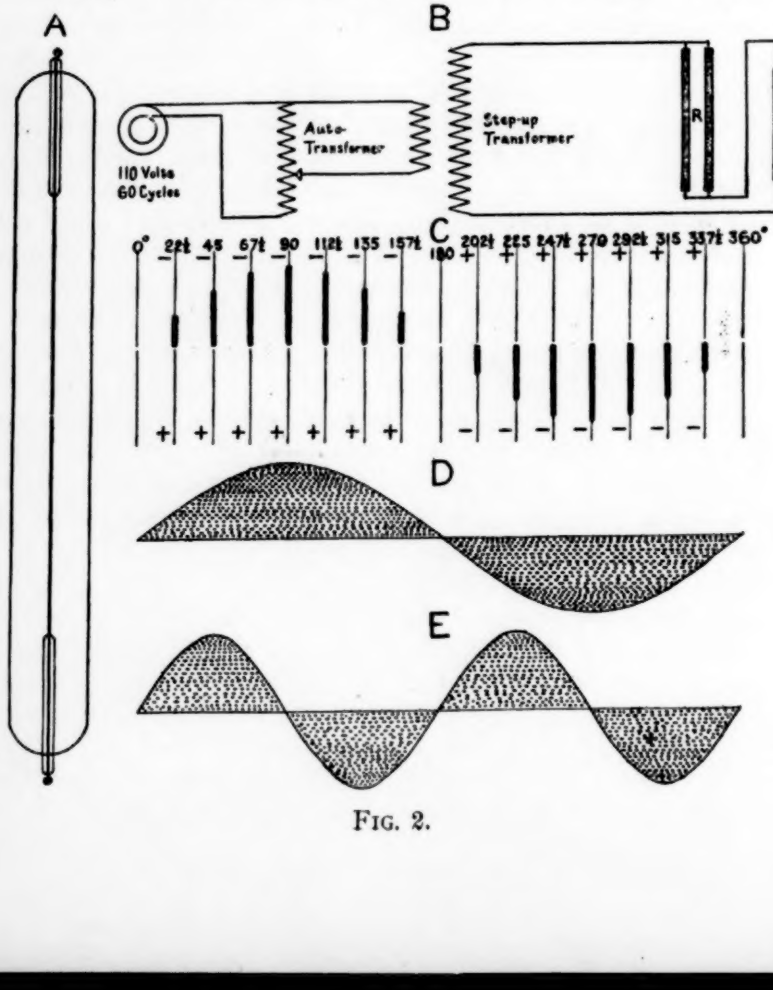


FIG. 2.

mirror while the oscillograph tube was operated by 60 cycle current from the city mains. E shows the form while the source was one phase of a small three-phase generator. Since the speed of the mirror was the same in the two cases—it was driven by a direct current motor—a comparison of the two sets of wave forms shows that the small generator is a 120-cycle machine.

Figure 1, A shows the wave form produced by the discharge of an induction coil through the tube. The speed of the mirror was about twice that used in the preceding experiments. Since I used an induction coil as a step-up transformer in obtaining the alternating wave forms, the only changes in connections necessary were to throw a double-pole, double-throw switch, thus connecting the primary of the induction coil with a 110 volt, direct current circuit, including a suitable resistance and a Wehnelt interrupter; and to connect the two halves of the water rheostat in series. The latter change was necessary because the maximum potential difference of the secondary terminals is so much greater when the coil is used as an induction coil than when it is used as a transformer.

Figure 1, B shows the wave form produced by the discharge of two Leyden jars through the secondary of the induction coil. The water rheostat was not used. In fact, with apparatus mentioned the discharge was not oscillatory while the water rheostat was in the discharge circuit; for its resistance added to the other resistances in the circuit exceeded twice the square root of the ratio of the inductance of the circuit to its capacity.

$$R \angle 2\sqrt{L/C}$$

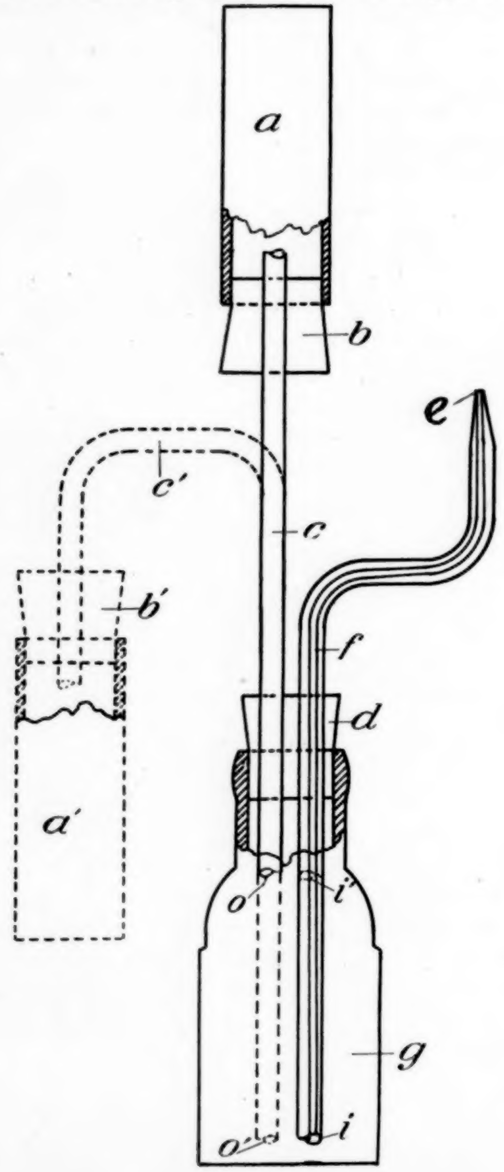
By making suitable changes in the amount of inductance and capacity in the discharge circuit, it is, of course, possible to show the dependence of the period of oscillation of the discharge circuit upon the magnitude of the product of its inductance and capacity.

In conclusion, I wish to call the attention of the reader to the fact that all of the apparatus needed to perform the experiments described, except the oscillograph tube itself, is standard apparatus, and is, therefore, already in the possession of every well-equipped school. A suitable water rheostat may, perhaps, not be at hand, but one can very quickly be made up from standard material.

A STUDENT APPARATUS TO ILLUSTRATE DIFFUSION OF GASES.

By William Lloyd Evans and Charles R. Parkinson,
Ohio State University.

The piece of apparatus described in this note is one patterned after the well-known larger pieces of lecture apparatus illustrat-



ing diffusion of gases, and is intended to be used by students in a laboratory course in General Chemistry. It has been in use in this laboratory and a report is made of it in the hope that it may be of some help to others. All the parts can be assembled by the student in a few moments, and excellent and satisfactory results may be obtained by him. The parts are: *a, a'* porous clay thimble 1" x 2¾"; *b, b'* number 4 single perforated rubber stopper; *c, c'* glass tubing; *d,* double perforated rubber stopper; *e,* glass jet; *f,* capillary glass tubing; *g,* 60 c.c. bottle; *i, i'* openings; *o, o'* openings. When the bottle *g* is partially filled with water and the porous cell *a* is surrounded by a beaker of hydrogen, the water plays from the jet *e* in the well-known manner. The converse phenomenon may be observed by the student by disconnecting *a, b, c, o,* and attaching *a', b', c', o',* and then surrounding *a'* with a beaker of carbon dioxide. The small porous thimbles were kindly prepared by the Department of Ceramics of this University.

RAILROADS NEEDED TO DEVELOP GOLD MINING IN ALASKA.

The advances in lodge-gold mining development in the Yukon basin of Alaska during 1912 were largely confined to the Fairbanks district, according to A. H. Brooks, of the Uinted States Geological Survey. There was also a small lode mine in operation in the Innoko district, and a little work was done on lode prospects in the Chandalar, Fortymile, and other Yukon districts. Most of these localities of lode occurrence are so isolated that the cost of operation is almost prohibitive. It is only through reducing transportation costs by building railroads and wagon roads that any advances in the lode-mining industry of inland Alaska can be brought about. Generous railroad development in Alaska would result in the opening up of innumerable rich mineral districts.

CHINESE REPUBLIC STUDIES OUR FOREST METHODS.

David Z. T. Yui, formerly secretary to the vice president of the Chinese Republic, is now traveling in this country to learn modern methods for adoption in China. He is at present in charge of the lecture board of the Chinese Y. M. C. A., which is in close touch with the new government and is aiding in putting into effect an educational campaign for the citizenship of the republic.

While in Washington recently, Mr. Yui spent some time investigating the work of the forest service, in order that he might find out whether its organization and methods would be of value to the newly created department of agriculture and forestry in China. In speaking of this part of his work, Mr. Yui said:

"In the matter of forest conservation the United States profited much by looking upon the disasters which were the result of the Chinese neglect of forestry. This was a great warning to you. Now we wish to profit by the improved methods of forestry which the United States has discovered and applied."

THE BEGINNER'S APPROACH TO PHYSICS.[1]

BY F. F. GOOD,
Columbia University.

It is difficult to foresee just what will be the outcome of the present sentiment of discontent among physics teachers. A. S. Bright of London began a recent article as follows: "Educationists today are realizing that back of learning is interest. Without interest teaching is futility. A child naturally takes more interest in that which he feels is useful. . . . Is our science really of the practical type that will be of use in everyday problems, and in what way can we make it more useful? . . . The success of our teaching is judged by the effect it has upon the child's attitude toward the world. If it makes him strong and self-reliant, an active investigator and discoverer and not a passive recipient, then we are justified."

In our own country we need not travel far to find a vigorous feeling of unrest among physics teachers. If the programs of half a dozen recent association meetings are an index of the general attitude there is one question that is uppermost in the minds of American physics teachers—How shall we relate physics more closely to life? It is an open-minded inquiry—a careful search for the best in science teaching.

Every wide-awake physics teacher, sooner or later, comes up against the stone wall of the physics-teaching dilemma. We cannot serve two masters. We cannot satisfy the prescribers of a course emphasizing formal generalization in science on the one hand, and, at the same time, satisfy the specialists in education who insist that the approach to science is through experience. The only sane and practical way out of this difficulty is to give every capable high school physics teacher the privilege of teaching the kind of physics he succeeds best with, and, in public education his success will some day, if not now, be measured not so much by the student's ability to rehash the conventional statement of so-called principles on an examination sheet; but rather, good teaching will be judged from the standpoint of the teacher's resourcefulness in meeting the social need of human life.

Unfortunately there are still remaining in this country certain systems of dogmatic teaching whose followers pride themselves in prescribed formalism. Disciplinary physics will ap-

[1]Lecture-demonstration before the New York Physics Club, May 24, 1913.

peal only to a special few. In the high school, physics should appeal to the masses, for who will assume that high school physics cannot and should not be made primarily of service to the general public? Herein lies the splendid opportunity for the physics teacher of broad sympathy to exercise his teaching-skill not so much in scientific abstraction but in scientific education for society and for the public welfare.

We need not feel under obligation to attempt to define specifically what socialized physics is. It is the kind of physics that sets out to meet the social need and not some other need. It may differ in different communities as widely as the public need. The teacher is the one competent individual to decide what shall be taught and how; and as his equipment he should have enough of life's experience and educational good-sense to solve it aright.

The pipe-organ presents a familiar problem deserving a far more enriching treatment in a physics course for purposes of general education.

The pipes which ornament the front of the church-organ are sham pipes. In science we are not at all concerned about shams no matter where we find them. Our interest rests upon real things. It is the business of the physics student to look behind the sham pipes and attempt to discover how all the various ranges of tones originate. No problem is more strikingly simple and at the same time so full of complexities as the study of these interesting tones, ranging from the shrillest high-pitched whistle to the thunderous low bass notes which actually set the whole building into sympathetic vibration.

When the organist strikes a certain key we sometimes feel the pew give forth a quivering response. Pews of definite lengths and definite materials are more likely to respond to tones of definite pitch. The pew vibrates in unison with definite tone pulsations. Tones of other pitches have little or no effect upon the pew. Windows and many other surfaces are often agitated in the same way by certain notes of the organ. A deep bass voice may also set a pew in vibration. These things are not at all difficult to understand if we remember that musical sounds are caused by extremely rapid pulsations in the air ranging from fifteen or twenty vibrations per second for the lowest tones to thirty or forty thousand vibrations per second for the highest tones we hear. These pulsations travel in rapid succession from a given source at the rate of about 1100 feet per second.

The massive pipe-organ with its magnificent tones will bear investigation quite as creditably as many of the sermons we hear, and such an inquiry may be even quite as intellectually stimulating.

If we climb through the interior of the pipe-organ we find rows of dusty pipes, some very large, others exceedingly small. Some are made of wood, others of metal. Each is capable of giving its own definite tone when the organist presses a key letting a draught of air under slight pressure pass across the end of the pipe. How are these tones produced? We may illustrate it by means of a series of eight tall bottles such as ordinary olive bottles. It requires no special musical skill to fill these bottles with the necessary amounts of water so that the air columns have the correct lengths to produce a familiar melody like "My Country 'Tis of Thee." The bottles may be pitched to the key of G. If we want to play a selection in some other key it will be necessary to change the lengths of the air columns slightly. In order to make these air columns emit their characteristic tones we must devise some scheme to set the air-column above the water into vibration. The best way to tune up the bottles, perhaps, is to vary the amount of water till the proper tone in some familiar selection is emitted.

Any device for directing a ribbon of air across the mouth of the bottle will serve to set the air-column into vibration. An ordinary tin tube flattened at one end to a narrow slit will serve this purpose. It should be about an inch in diameter. Attach a rubber tube of large size to this metal tube. This may be held in the mouth while the other end is directed against the tops of the bottles. A wing-top from a Bunsen burner will handsomely serve the purpose of the metal part. After a little experimenting excellent tones may be produced by blowing through the tube and directing the ribbon of air across the mouth of the bottle. A long air-column gives a low tone and a short air-column gives a high tone.

The results produced by a series of bottles of all sizes are particularly enlightening to a class of beginners in the study of sound. Similar results may be obtained with a series of flasks, graduates or test-tubes. If the vessel is long and narrow and of regular shape the number of vibrations per second may be determined by multiplying the height of the air-column in feet by four and dividing this result into 1100 feet.

I take my ring of keys from my pocket. In the end of one

is a hole about half an inch deep. Using this short air column I find I have no difficulty in imitating a day-old chick lost from its mother. Another key has a hole about a quarter of an inch deep. It gives a tone extremely shrill something like the cricket's chirp. A third key having a still shorter air-column emits a rasping sharp tone almost inaudible. We have about reached the limit of the power of the human ear to interpret vibrations—a column of air vibrating twenty-five or thirty thousand times per second. Beyond this no doubt there are yet higher tones but the human ear is not sensitive enough to catch them. We may speculate about the insects hearing and producing tones that we know not of since their vibrations may be too rapid for the human ear.

My fountain-pen cap gives its characteristic tone. Taking a large gallon bottle and filling it partly full of water we get an imitation of the buzz of a bumblebee. In the same way a two-gallon bottle may be adjusted to sound like the flutter of a humming-bird. Then by drawing out some water we pass the lower limit of hearing—twenty or twenty-five vibrations per second. Here again the ear loses the power of interpreting the vibrations as tones. Among an average group of students some will declare they hear a musical sound; others will declare emphatically that there is no sound. When the large bottle stands upon a table which reinforces the vibrations as a resonator, I have had certain students who insist that while they cannot hear the tone they think they are able to feel the tone in their chairs.

As a boy I used to get stung fighting bumblebees with shingles and I welcomed the idea suggested by an old native that a jug partly filled with water would cause the bees to drown themselves if placed near the nest. I tried the scheme with varying success but never could tell why it worked better at one time than another. Probably at one time the air-column in the jug was just long enough to vibrate at the same rate as the buzz of the bees' wings and thus excite them more, while at another time the jug was either too full of water or not full enough.

A plain glass tube with an inside diameter of half an inch, and a length of about twelve inches is a very instructive piece of apparatus. It may be employed to illustrate the operation of a number of musical instruments. Hold the blower against the end of this tube and move the tube upward and downward in a jar of water. Any desired pitch may be obtained in this

way, and we may run a complete scale of musical tones. If we mark off the proper lengths on such a tube it is not difficult to produce the notes required for a simple selection. We have the possibility of playing "America" on a single glass tube by properly varying the length of the air-column over the water in the jar.

This foot-long glass tube is also very rich in overtones when it is used either as an open-pipe or a closed-pipe. Vibrating the air-column as an open-pipe, the fundamental tone has a pitch corresponding to the octave above Middle C. By varying the position of the blower and the pressure, it is quite easy to strike an interesting series of overtones corresponding to the regular series of vibrating segments of the open-pipe. Thus we have a series of tones corresponding to the vibrating ratios—2-4-6-8-10, etc., making the first overtone of the open-pipe an octave above the fundamental. These experiments illustrate how it is possible to get such a great variety of tones on instruments like the trombone, the cornet and the flute. The keys on all kinds of horns serve to change the length of the vibrating air-column thereby changing the pitch of the tone. Each change of length has its own series of overtones and this gives the musician his whole range of desired notes. If we close the one end of the foot-long tube the fundamental is an octave lower than when it is vibrated as an open tube. The fundamental is Middle C, and the overtones available follow as vibrating segments corresponding to the ratios—1-3-5-7-etc.

Professor Mann has said a great deal about making physics significant and making our problem appeal to the student as worth his while; Professor Dewey insists upon interest as a fundamental condition in scientific education; Professor McMurry contends for motivating the teaching materials of public instruction; and Professor Woodhull has long stood out in behalf of a type of physics teaching in the public school which has for its aim,—to cultivate and foster the scientific spirit by enriching and illuminating a problem that falls within the learner's experience. This seems to be the way great scientists have been made since Galileo blazed the trail out of medieval dogmatism.

A PYROMETER FOR LABORATORY USE.

By J. B. Kremer,
University of Detroit, Detroit, Mich.

The thermo-electric pyrometer described in the present article, although not well adapted for commercial purposes, has many advantages as a laboratory instrument. A number of such pyrometers can be put together with instruments already found in every laboratory and without additional expenditure. All that is needed is a galvanometer, a small resistance box, a slide-wire-meter wheatstone bridge, a constant current cell like a Daniell or a storage cell, and a few feet of Ia Ia and Superior wire, or Ia Ia and iron wire. The scale of the instrument can be made of any desired length. If an ordinary slide-wire bridge is used the scale will be a meter long. The scale used by the writer consisted of a specially constructed resistance board having a total length of wire of 720 cms. The greatest advantage of the apparatus, however, lies in this that it can be put together and calibrated by the student himself, and tends therefore to arouse his interest.

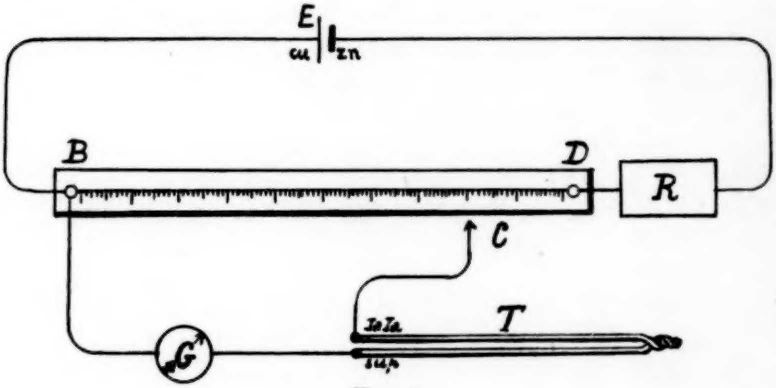


Fig. 1.

The method consists in balancing the E. M. F. generated in the couple T (see Figure I) by the fall of potential along the wire B D. The cell E is connected in series with the resistance R and the resistance wire B D. By properly adjusting the resistance R, the fall of potential between the points B and D can be made equal to the maximum E. M. F. generated in the couple T, which is about 52 millivolts for 1000° C. If then the positive pole of the couple (Superior wire) is connected to the

positive end of the bridge or B, through the galvanometer G, a position can be found on the wire B D for any particular temperature by shifting the contact C, where the galvanometer will indicate no current or where the fall of potential is equal to the E. M. F. generated in the couple T. The point B therefore is the zero point of the scale and the number of millimeters between the points B and C can be taken as the number of scale division for that particular temperature.

The calibration of the instrument consists therefore in determining a number of such points where the galvanometer comes to rest when the couple is heated to a known temperature. The reliability of the apparatus depends consequently on the precision with which the fall of potential between B and D can be maintained or reproduced. This drop of potential must therefore be accurately measured when the instrument is calibrated, either by placing a low reading ammeter in the circuit, or by observing the deflection when a galvanometer is connected to two definite points on the wire B D. A double-pivot instrument is best adapted for this purpose since its reading is not affected by a change of position. If a D'Arsonval galvanometer is used, care must be taken in leveling the instrument properly and the scale reading when the coil is made to swing to the right and to the left must be taken as comparison reading. Thus it will be easy to reproduce the same drop of potential by adjusting the resistance R until the galvanometer shows the same deflection as before. A practical arrangement is to permanently connect a short wire to the same binding post of the galvanometer to which the Superior wire of the couple is connected. With the free end of this wire contact can be made at any time at a given distance from B and thus any change detected, should it have occurred.

The couple may consist of any reasonable size and length of wire, since the method adopted entirely eliminates the resistance of the couple. For most purposes it will be found convenient to use 3 or 4 feet of No. 12 Ia Ia and Superior wire, or Ia Ia and iron wire. The wires are twisted together at one end, one or two turns will do, and then welded together. A neat weld can be made by holding the twisted end in the flame of an electric arc without allowing the arc proper to strike the wire. Only a weak weld is produced by using the wire itself as one of the electrodes.

To calibrate the instrument the following method has proved

satisfactory. After connecting the apparatus as indicated in the diagram, unplug in R about ten times the resistance contained in the bridge if a Daniell or Edison primary cell is used. If a lead-plate storage cell is used the proportion must be about 1:20. Next heat the couple to its maximum temperature, v.g., in a good Bunsen burner and shift the contact C at the same time towards D. If the galvanometer comes to rest before C has reached D, unplug more resistance till the sliding contact reaches D then measure accurately the strength of current or the drop of potential as explained above. A number of fixed points can now be determined on the scale by using the melting or boiling points of different substances as known temperatures. From the curve obtained by using the distance of the points from B as abscissae and the corresponding temperatures as ordinates, other unknown temperatures can easily be found by graphical interpolation.

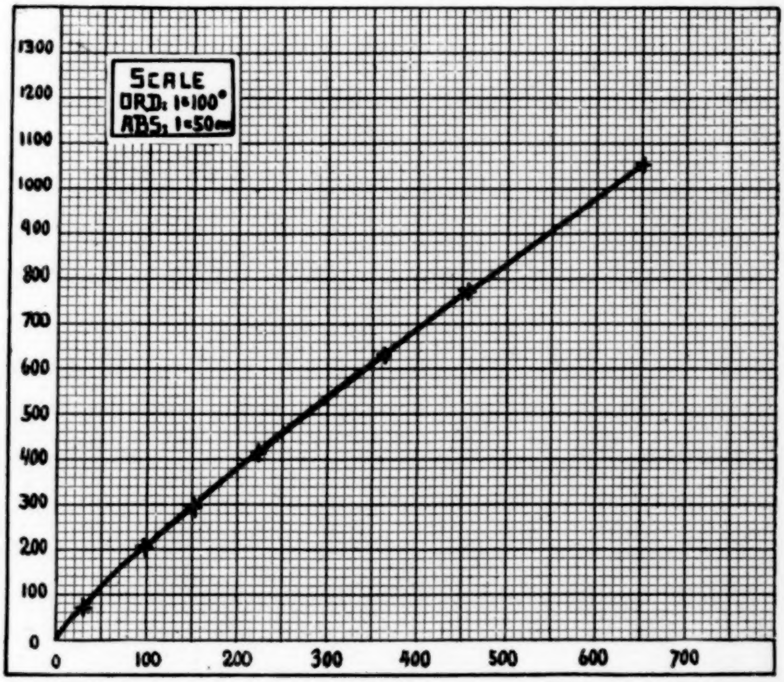


FIG. 2.

The curve given in Figure II shows the relation between temperature and the E. M. F. of an Ia Ia and Superior wire couple. Both these wires can be obtained from H. Baker, 101

and 103 Duane St., New York City. The curve shows that quite reliable results can be obtained with very simple instruments. The cell used was an Edison primary cell which made frequent readjustment of the resistance R necessary. The points were determined on different days, with different and rewelded couples. Instead of a sensitive galvanometer a millivoltmeter was used. The motion of the pointer, however, was observed by means of a lens on a stand.

The following fixed points were used:

	Hot End Temp. in Degrees.	Cold End Temp. in Degrees.	Rise in Temp. in Degrees.	Length of Wire in Cm.
Boiling point of water.......	99.5	26.5	73	31.5
Melting point of tin.........	232	30	202	98
Melting point of lead.......	326	31	295	151
Boiling point of sulphur.....	445	27	418	223
Melting point of aluminum..	657	27	630	362
Freezing point of salt........	800	30	770	455
Melting of copper	1084	31	1053	650

As may be seen, the curve tends more and more to become a straight line as the temperature increases, which greatly facilitates interpolating for unknown high temperatures. If the boiling of sulphur is used as a fixed point, the couple must be protected by a glass tube closed at one end, since the action of the sulphur lowers its E. M. F. The escape of sulphur fumes, which rise in great quantities long before the sulphur boils, can be entirely prevented by boiling the sulphur in a flask with a long neck, and by inserting a long plug of asbestos loosely into the neck of the flask. The sulphur should boil freely when the point on the scale is taken. No protecting tube is needed to determine the other points. The best results are obtained if the substances are heated above the melting point and then allowed to cool with the couple immersed in them. The galvanometer will slowly move back and then remain stationary for a considerable time when the substance begins to solidify. This point is taken as the melting point. On reheating the substance, the galvanometer will again become stationary at the same point when the substance begins to melt. The melting point of copper can easily be found by placing a short piece of a copper rod across the ends of the couple, which is not twisted in this case, and slowly heating the whole till the copper begins to melt. With a little care this can be repeated a number of times without the copper becoming detached from the wires. The wires should be about

6-8 millimeters apart. The melting points of other metals are not so easily determined in this manner, owing to their low melting points. The method, however, saves time and material where great accuracy is not required. To determine the melting point of salt a nickel or graphite crucible must be used.

TEACHERS OF AGRICULTURE BETTER PAID.

It pays to teach agriculture. According to a bulletin just issued by the United States Bureau of Education, the teacher of agriculture in the high school usually receives a considerably higher salary than the teacher of other subjects. The most usual salary for male teachers in high schools in the United States is $700, but for teachers of agriculture in the group studied the most usual salary was $1,200.

"Lack of teachers" is the explanation offered by the authors of the bulletin, C. H. Robison and F. B. Jenks, to account for the relatively higher remuneration for those who teach agriculture. When the subject was first introduced into the schools a short summer course provided sufficient training, but with the extension of the work to include several years of careful high school study under scientific farming conditions, there has come a demand for trained agricultural teachers that has exhausted the supply. Furthermore, many of the states are giving aid to local high schools for agricultural instruction, so that these schools are able to pay better salaries for teachers of agriculture than for teachers of other branches.

Not only is it found that the average pay of special instuctors in agriculture is higher than of other teachers, but that teachers who are able to give such instruction in addition to regular work command better salaries than they otherwise would and are more likely to be advanced to principalships than if they did not have the agriculture.

Better pay for teachers of agriculture is only one of many indications of the remarkable growth in importance of this school subject in the past four or five years. Agriculture had been taught here and there in the schools for many years, but made little impression on the curriculum before 1906. In the year 1906-07 there were about a hundred secondary schools in the United States that gave some sort of agricultural instruction; in 1910 about eighteen hundred schools reported to the Bureau of Education that agriculture was taught as a separate study in the high-school department; and the 1912 figures as far as compiled indicate a very large increase over previous totals.

Elementary instruction in agriculture is now required in seventeen states, as follows: Alabama, Arkansas, California, Florida, Georgia, Louisiana, Maine (rural), Mississippi, Missouri (rural), North Carolina, North Dakota (rural), Ohio (rural), Oklahoma, South Carolina (county boards may require it), Texas (in districts with less than 300 children), West Virginia, and Wisconsin (rural).

THE MANIPULATION OF THE ACHROMATIC PRISMS IN PHYSICS TEXT-BOOKS.

By Von Dr. Schafer,
in Friedberg, i. H.

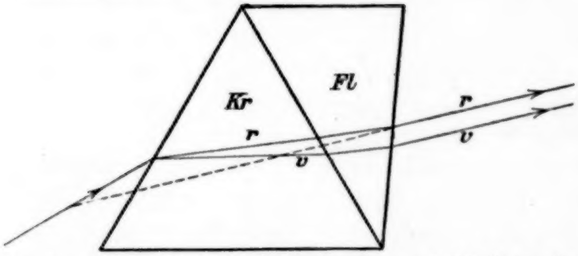
The achromatic prisms are never put to practical use. Nevertheless, in order to fully explain and simplify the principles and technique of achromatic lenses, it is necessary to first teach the pupils, by means of these prisms, how the light is broken up and refracted.

If the chapters on "achromatic prisms" in our text-books were to be thoroughly searched it would be found that the figures and drawings, which illustrate the refraction of light, differ greatly in the various editions. Should one try to prove the accuracies of these drawings it is hardly possible that a perfect one could be found among them. The following text-books, Grimsel, Warburgh and Sumpf, are exceptions for they are not illustrated. The rest which contain diagrams and which I have had at hand are, the works of Mueller-Pouillet, Poske, Kleiber, Donle and Waeber-Unverricht.

In the text-book by Donle an illustration shows the divergence of the red and violet rays, when entering a prism, but it also shows both these rays, after having separated, entering a second prism at precisely the same place. This is not the case, however, for on leaving the first prism, the violet ray must be diverted more than the red ray. This is obvious without taking into consideration the fact that the angle of incidence of the violet ray, when it strikes the side of the prism is already greater than that of the red ray. The Donle view is also contradicted by the illustration procured by accurate prismatic experiments. The illustration shows that after the rays of light leave the second prism they become a single beam of white light, although a faint trace of the red and violet is noticeable on either edge.

In Waeber-Unverricht the fault lies in the fact that the rays of light in going from crown glass into flint glass, which is the denser of the two, are pictured as bending away from the perpendicular. According to Poske, the index of refraction between air and crown glass is 1.530, that of flint glass is 1.635; then the relative coefficient of refraction, which is found by dividing the latter quotient by the former, is 1.069. This is only a very little greater than one, nevertheless it is greater and shows that when the ray of light goes from crown glass to flint glass its direction is altered, be it ever so small, towards the perpendicular.

The course of light rays could be illustrated, although not accurately, by two parallel lines drawn through the prisms, but to have them both bend away from the perpendicular, is not only incorrect but very confusing. But to illustrate correctly the direction of the rays, they must bend toward the perpendicular (see figure). The figure, in all probability, greatly exaggerates the change in direction but this is the case in all figures which illustrate refraction in a simple prism.



In the texts of Mueller-Pouillet, Poske and Kleiber the prisms are separated by a shaft of air. The rays, leaving the air and entering the flint glass prism are bent toward the perpendicular, but the angle of refraction used is greater than the angle of incidence on the back side of the crown glass prism, and by reducing the width of the air shaft the rays seem to bend away from the perpendicular. This shows that these text-books have the same faults as that of Waeber-Unverricht.

Furthermore, in these text-books, the rays in the flint glass prism are drawn parallel, at least a difference in direction is not apparent. But since the rays of light are not parallel except after leaving the flint glass, it is necessary that the angle of incidence of the violet, because of its greater refractability, must be smaller, at the back of the flint glass prism, than that of the red. In the above illustration the lines in the flint glass diverge but slightly, but this divergence becomes more apparent when the beam of light, striking the crown glass prism, forms a greater angle of incidence. For smaller angles of incidence the rays converge slightly. In this case the angles of incidence of both rays, which strike the back side of the flint glass prism, lie above the perpendicular.

Good results can be obtained if a beam of light is so directed as to make a definite angle of incidence with the crown glass prism. The angles of incidence and refraction of the red and violet rays can then be calculated. As a basis for this experiment prisms having angles of refraction of 60°—35° were used. —*Zeitschrift für den Physikalischen und Chemischen Unterricht.*

SEX EDUCATION FOR SCHOOL CHILDREN.

By Clarence W. Hahn,
The High School of Commerce, New York City.

Educators are rapidly coming to realize the importance of formal instruction in human reproduction and the sex relations of mankind. Several rather perplexing questions confront those who have given serious attention to such matters. At what age, by whom, and in what manner shall this information be imparted? It is to these questions we seek the answer. As to the age and preceptor, the matter which follows is not intended to be related.

The subject matter of sex instruction and manner of presentation are wholly dependent upon the standards of moral purity which it is desirable to maintain in the minds of young people, and the primary motives of such instruction.

People differ in their standards of sexual morality as they do in regard to all other social standards. Some entertain high moral ideals and live in harmony therewith but scarcely a majority of mankind can be expected to behave in accordance with the most exalted standards. It is not only impractical to enforce imaginary or ideal standards but it is probably undesirable to do so if it were possible. What then, is the average standard of sexual morality that society must maintain, in order to remain perpetually sound and prosperous?

As individuals, our ideals are wholly dependent upon our early education and home environment. Frequently they are artificial and imaginary. Nature's realities are apt to be shocking to the refined sensibilities of cultured man. Death and birth, though normal incidents in nature, are alike shocking to the most exquisite mental conceptions of human life. The biological processes of Ontogeny and Phylogeny are both beset with natural tragedies with which man reluctantly reconciles the philosophy of his imagination. It is obvious that our judgment should not be influenced by sentiment. What of morality, then, is tangible and harmonious with nature? In the following pages will be found the evidence upon which we base our conclusion that such a standard of sexual morality should be hoped for in society as would maintain the family unit continuously and unimpaired from generation to generation and provide the best possible home conditions for the environment of children.

Should evidence of the importance of the family as a funda-

mental political unit of civilized society be desired in addition to that here given, it will be found in Westermark's History of Human Marriage. He there shows that the higher the status of woman amongst the various races of men, the higher is the scale of culture. He traces the origin of the family unit from the apes and furnishes evidence of the political relations of family and tribal units.

The standard of moral purity and conduct which sex instruction hopes to attain should at least be all that is necessary to guarantee good homes. There are three additional motives for sex instruction.

For the masses, it is not absolutely essential that all youth should be sentimentally pure in mind, modest outwardly with concealed, but not restrained, emotions. Far better is it that youth should not be ignorant as to their responsibilities in sex matters and nature's provisions for procreation. The man or woman whose moral purity is such that he or she is above the seemingly degraded processes of regeneration, defeats the purpose of nature as much on the one hand as does the lust of the impure minded whom venereal diseases and degradation have rendered either sterile or unfit to maintain homes. We seek to establish unsentimental, sane, and practical ideals in regard to this whole matter.

Besides the opportunity which formal instruction offers to forewarn young people of the dangers lurking in self-abuse and venereal diseases there is also need of constructive morality. In contrast with sexual purity due to ignorance or undeveloped sexuality, it is highly desirable to cultivate wholesome ideals of personal and public morality, ideals that are real and practical in the face of all the grewsome facts revealed by an intimate knowledge of the subject.

These four demands for sex education may be simultaneously met by the course outlined below.

It is not to be understood that the instruction in sex matters should assume a separate existence in the mind of the pupil. It should, if possible, be so related to other matter that it is, as approached by the pupil, an incidental feature. To provide these conditions, the matter should be presented as a part of a regular course in the study of living things (biology). In order to give a concrete idea as to the subject matter of sex hygiene and the manner of relating it to an otherwise rational course in biology, we give in the following pages parts of the

text of such a course. The remainder of the text would naturally vary according to the local requirements. To be pedagogically presentable ample illustration is necessary. The material for this is suggested in parentheses.

In order to present more forcibly the moral aspects of the subject, it has been our custom to dwell extensively upon *habit* and *character* and their formation from a physiological point of view. The study of bacteria and communicable diseases has likewise proved to be a desirable approach to the comprehensive discussion of social diseases. A true appreciation of the place of sex in nature is to some extent dependent upon the gradual elimination of the mental attitude which results from constant mental contact with artificial creations, human things and human institutions. The body must conform to the requirements of a natural environment. In a measure the intelligence must also conform to supreme realities. Nothing serves this purpose better than the principles which are usually embodied in a course in biology.

The matter and presentation necessarily vary according to the age and sex of the pupils.

The first approach to the question of reproduction should be in a discussion of the flower which logically follows after a period spent in the study of plant structures and life processes. One would suppose that this period would be six or eight weeks at least.

After a study of the parts of a flower the pupil comes to realize that a flower is of no use whatever to the parent plant, that its parts are natural devices which serve to bring together two cells in the process of fertilization. The pollen or male element is thus endowed that it may travel the more easily and bring about the union of distantly related gametes. The ovule or female element has its special qualities so that food may be supplied while the embryo plant is developing and the young plant may be protected and be supplied with reserve nourishment in the seed, to be used at the time it germinates and seeks to get an independent foothold upon the earth. The scattering of seed so that young plants will not crowd one another is also accomplished by the parent plant. (Based on a laboratory study of flower models, flowers, sections of ovules, pollen grains fresh and germinated, seeds, fruits and other seed spreading devices, pictures.)

A broad point of view of the flower and its purpose does not

exclude its part in the redistribution of characters. After illustrating (charts) what is meant by a character and variability, pictures or specimens to illustrate heredity, introduce the subject of crossing and its effects upon variability. Without dwelling upon exceptions, the general tendency of crossing to produce variability in characters and of close or self fertilization to decrease variability, attention is called to the effects of selection upon individuals reproduced by both means, namely, the more rapid change of the characters. We then have an explanation of the universal occurrence of fertilization in nature, especially of the remarkable device for bringing about cross pollination by insects. Familiarity with the laws of heredity and their applications in plant and animal breeding leaves in the mind of the student an impression that all processes involving fertilization are natural and exist for definite purposes (Laboratory practice involving specimens or pictures of variations, mutations, hybrids, charts of genealogies).

It may be objected that this conception of sex as applied to plants is not scientifically accurate. It at least approaches the truth in a general way and is far better than a total misconception of a universal natural phenomenon.

The further study of botany may continue after completing the flower and heredity. At some point in the work upon cryptogams it is most desirable that the bacteria and possibly fungi should be rather exhaustively treated, because of their economic importance and their relation to health as well as for the better understanding of social diseases which are, of necessity, rather briefly discussed. But before considering animal reproduction, it is highly desirable to take up the nervous system and lead up to habit and character. Starting with the neurone theory (illustrated with cells and fibres in microscopic preparations) the simple spinal reflex (illustrated with reflex frog or charts), the nerve fibre tracts in the brain and spinal cord and localization (sections and charts) lead up to higher motor reflexes (demonstrated by reference to skill acquired in familiar games, etc.) and finally purely psychical reflexes (reading, multiplication tables, etc.). With a little skill it is possible to point out in the class room, moral attributes that are becoming or have become subconscious reflexes. A demonstration of the growth of character in this manner is much more forcible than when dogmatically presented. The youth of a large city may easily be made to realize the influence of environment and the

will of an individual in the formation of character. A few concrete illustrations easily convince them that an individual has power to modify habits while young but only with great difficulty and in respect to but few habits when mature. These arguments should be applied to the habits of industry, optimism, morality, and honesty. The mind of the most hopeless boy is usually in a fair state by this time to consider the problems of life seriously.

Either in connection with the study of zoölogy or human physiology, animal fertilization and development may be introduced. Practical fish culture is not only an important industry based on biological processes but it offers an opportunity to introduce the topic of fertilization and development in all its details. Ovaries and spermaries should be previously located, along with the other organs in a dissected fish or frog. Then the methods of catching, transporting and stripping the female fish, the fertilization of the eggs by chopping up testes and mixing the eggs and milt, lead up to an inquiry into the structure of the egg and sperm. The methods of hatching dovetail well with the study of cleavage of the egg and the development of the germ layers.

Reference should again be made to the relation of fertilization to variability and heredity. More or less repetition of the principles brought out in connection with plant breeding may profitably be illustrated from the animal world. The existence of sexes and fertilization as a process should not be pictured without emphasizing the necessity of such in nature.

Since it is not wise to dwell upon the anatomical side of reproduction in man with young pupils of either sex and because it is most essential that they should have a knowledge of the reproductive organs and processes in man, we have adopted the following indirect method of presenting these very facts without offense. The same sequence of structural provisions, namely that of the vertebrate series, that reveals the anatomical conditions in man, may be utilized to show why nature has provided the organs in question and to interpret properly the instincts and social institutions which nature has associated with regenerative processes. Thus an otherwise commonplace subject may be converted into one of great moral and ethical value. In these discussions we make use of the following facts: Fish produce many thousands of eggs in order to replace those that die. But in a given species two eggs for each pair of adults of

average age will replace those that die provided both eggs hatch and grow to average age. Some fish eggs are not fertilized, many are eaten, large numbers of the very young fish are either eaten or die for lack of food. This is because the provisions for their protection are very meagre.

Reproduction amongst amphibia provides at least one advance in the method of development. The chances of failure in the process of fertilization are prevented as in most fishes by the deposition of milt directly upon the egg. A gelatinous secretion of the oviduct and an instinct of the parent make for greater security of the young during growth. This added protection provides a longer period of infancy and consequently a higher degree of development is possible.

The development of reptiles introduces far greater protection to the eggs together with a more certain method of fertilization, since this process is internal. It is accomplished by mating instincts which cause the males to inject the milt into the oviduct before the eggs receive their covering. Having been fertilized, the eggs may receive layers of albumen for food and shell for protection. Both serve to keep down mortality. The nesting instinct of reptiles is additional protection to the young. An opportunity is here offered for an interesting diversion to the study of reptilian habits.

Both birds and mammals present additional advances along structural and instinctive lines. By developing these, one not only presents a clear concrete conception of the organs involved in fertlization and the way by which the young are fed during development, but the principle by which nature has extended the period of development and reduced the number of young is forcibly demonstrated. Thus in birds the large amount of yolk affords a longer period of development. The albumen, shell and shell membranes, which are derived from the glands of the oviduct, still further protect and lengthen development and at the same time make internal fertilization necessary. Fertilization becomes certain. The instincts providing for the introduction of milt into the oviduct rank with shell and stored food as means of protecting (sections of boiled eggs, birds' nests, etc.) the young while in a helpless condition. From any other point of view these instincts have no moral motive. But, since they exist in order that the eggs of birds may be certain to be fertilized and receive a large quantity of food (albumen) and an effective protection (shell and membranes) the mating

instincts (pictures of pheasants mating, of birds feeding young) come to have a moral aspect which needs no apologies. The care and attention which young birds sometimes receive in the nest because of the nesting and parental instincts are additional evidence that the principle is far reaching in nature and capable of asserting itself in every phase of organic development. Some of the most phenomenal achievements of organic evolution are in response to this principle.

Mammals supply many instances of both structural and instinctive provisions which, in accordance with this principle, afford additional protection to the young. The climax of the principle is encountered in man, where conditions are so exalted as to embody the highest principles of morality and ethics. It is sufficient to mention that special organs for internal fertilization are provided. Neither yolk, albumen or shell are necessary (sections of mammal ovary) because the developing egg receives protection in the body of the mother and its nourishment directly from the blood of the mother (from the wall of the oviduct i. e. uterus). (Pictures and specimens of developing kittens in the placenta.) Hence the young are born with the organs of digestion sufficiently developed to assimilate milk which is supplied by a new structural device, the mammary gland. The latter has no other purpose than the feeding of the young. Through man's early appreciation of the food value of these secretions, cow's milk has come to be a universal food of both young and adults. (This serves to bring into contrast the artificial and natural view points.)

To compensate for such extensive structural provisions for feeding and protection before birth, fewer young on the average are required to replace the adults in most species of mammals than are necessary in birds and reptiles. At the same time many mammals having a long period of development arrive at a very high state of complexity, especially is this true of the nervous system.

The higher mammals have made their advances in protecting young through more highly developed instincts. Maternal and paternal instincts provide extended protection in many species of deer and apes. In the latter the mating is perennial and the bonds of family are expressed.

With so many incontrovertible evidences of nature's principle in regard to the young of both animals and plants, we have ample data for the rational interpretation of the instincts and institu-

tions of mankind. The purest love of youth, the passion of lust, the maternal and paternal instincts and jealousy have been called into existence for the protection and better development of children. The family is a unit of society which exists amongst all races both barbarous and civilized, independent of other social institutions. It is based on natural instincts and it exists for the welfare of the offspring.

The offspring of mankind are few in number and require a long period for physical, mental, and moral development. Amongst primitive people a language and a few crafts, manners and customs fit the individual for life but the natural demands of the civilized boy or girl are far greater. Besides the speech, manners and customs of his race he must know how to read and write, must be trained in some industry and must be habitually moral and honest in order that he may go forth to lead an independent existence. Since his home can not supply all his necessities, the community must provide schools and Sunday schools. Thus the civil unit augments the family unit in providing for the highest type of youth.

The earlier stages of development are scarcely possible without the home. Therefore the influences which tend toward the disintegration of the family or the degradation of the home are a peril to children. Such influences are contrary to a well defined organic law or principle of nature. There are four conditions in modern society which are commonly the cause of misfortune to young children and prevent them from receiving the protection and higher development which is their natural inheritance.

Unavoidable poverty is one of the commonest calamities by which the home is blighted. It is to the interest of the nation to remedy economic conditions which prevent the family from supplying youth those things which they must have for normal and full development.

Intemperance in the disposition of the resources of a family in like manner defeats nature's purposes. Drunkenness is not the only form of intemperance which interferes with the rights of the child. Gambling, extravagant dress, luxurious living and above all the idle indulgence of the parents' time at the expense of the moral education of their children, fall in this category.

From this point of view stability and harmony in the family unit are necessary for the undisturbed education and culture of children. Immorality of the parents results indirectly in dis-

ruption of homes for which the children and the nation must suffer.

Interference with natural processes in respect to the reproduction of fully developed human individuals is in no way so persistently defeated as by venereal diseases. A disease of the organs of reproduction which destroys the lives of the offspring or renders them weak, crippled or blind, is undoing what ages of evolution have accomplished for the economical rearing of perfect young. A disease which renders an individual sterile defeats one of the first organic laws of nature. The diseases here referred to are caused by two germs, namely gonococcus and treponema pallida. It is claimed by good authorities that the former causes the blindness of sixty per cent of the blind babies and thirty per cent of all blindness. It also renders the female sterile and frequently causes serious disease in the male to say nothing of indirect misery and desolation in life. Syphilis is equally a scourge to adults and offspring, the latter innocent, causing much misery, pain and death. Ninety-five per cent of the cases of agonizing forms of paralysis and of degradation equally unsufferable, are traceable to this disease. No victim escapes unscathed and a miserable death is the fate of many. Worst of all, those nearest and most dear to the victim of syphilis are exposed to the germs which are constantly leaving the body in its discharges. The young, the family, and the whole gamut of conditions necessary for civilized culture are thus sacrificed through the agency of these two diseases. They seem to be nature's penalty for unrestrained sexual intercourse. The exercise of natural instincts and sexual emotions by those living in harmony with nature's plan and maintaining homes for the protection of offspring which are the natural consequence of such intimacy, not only leads man and woman into the most moral and glorified state of existence calling forth the best qualities of character but protects both parties from the dangers of unrestrained lust. The unfortunate transgressors are, as a rule, misguided and ignorant. Primarily, they do not realize the purpose of sexuality in nature. Diseases that are inseparable from unpardonable shame and disgrace are so concealed by their victims that few persons know how common they are amongst those who defy natural, civic and canonical laws and terminate their line of inheritance by lives of lust and indulgence. It is reported by the best authorities that sixty per cent of all males in the United States and ninety per cent of a degraded class of

females have at some time in their lives, either syphilis or gonorrhoea. Without doubt the most of these persons contracted the diseases directly or indirectly from a class of fallen women who are victims of ignorance at the same time that they are victimized by the ignorant. It is obvious that venereal diseases are much more common than is usually supposed. Shame alone conceals them. Ignorant of the joys of a pure life, of the existence of diseases concealed by shame, and of the miseries and degradation that follow in their path, an army of men and women are perpetuating a scourge upon society and upon many innocent children whom nature intended to be protected and educated.

The reader will observe in the above detailed presentation of the matter relating to the biology of sex that the pupil is almost compelled to accept morphological adaptations in the same spirit that he accepts the adaptations of instincts and sociological institutions. If the teacher is sincere and has gained a moderate degree of sympathetic response from the class, it is difficult to see how harm can be done to those having the most refined sensibilities. It is indeed quite as important that instruction in matters relating to sex should not only uplift the lowly minded but leave the high minded youth no less exalted by having learned the facts.

The hygiene of sex is not a bad termination for a course if presented in this way.

PANORAMIC VIEW OF CRATER LAKE NATIONAL PARK.

A striking panoramic view, in six colors, of Crater Lake National Park is the latest of the national park publications issued under the direction of Secretary Lane. This view shows the park as it would appear to an observer flying over it, the ridges, peaks, and valleys being shaded and colored in order to show the relief. This panorama, which may be purchased for twenty-five cents from the Superintendent of Documents, Government Printing Office, Washington, D. C., measures 16½x18 inches, and has a horizontal scale of one mile to the inch.

PROBLEM DEPARTMENT.

By E. L. Brown,
Principal North Side High School, Denver, Colo.

Readers of this magazine are invited to send solutions of the problems in which they are interested. Problems and solutions will be duly credited to their authors. Address all communications to E. L. Brown, 3435 Alcott Street, Denver, Colo.

Algebra.

359. *Proposed by H. E. Trefethen, Waterville, Maine.*

Show that the sum of two rational integral cubes can not be equal to a third rational integral cube.

No solution received.

357. *Proposed by Elmer Schuyler, Brooklyn, N. Y.*

Solve:
$$x^2-2xy+y^2+2x+2y-3=0. \qquad (1)$$
$$y(x-y+1)+x(x-y-1)=0. \qquad (2)$$

Solution by Elmer Schuyler, Brooklyn, N. Y., and R. M. Mathews, Riverside, California.

$$x^2-2xy+y^2+2x+2y-3=0. \qquad (1)$$
$$y(x-y+1)+x(x-y-1)=0. \qquad (2)$$

Equation (2) may be written
$$x^2-y^2-(x-y)=0.$$
or
$$(x-y)(x+y-1)=0.$$
Whence
$$x=y \quad \text{or} \quad x+y=1.$$

We then have the two systems of equations to solve:

$$(x-y)^2+2(x+y)-3=0, \qquad (x-y)^2+2(x+y)-3=0,$$
$$x-y=0. \qquad x+y=1.$$

Whence
$$x=\infty,\ \tfrac{3}{4}. \qquad \text{Whence} \qquad x=0,\ 1.$$
$$y=\infty,\ \tfrac{3}{4}. \qquad y=1,\ 0.$$

Geometry.

358. *Sequel to Problem 349.*

The difference of the areas of the triangles formed by joining the centers of the circles described about the equilateral triangles constructed—(1) outwards; (2) inwards—on the sides of any triangle, is equal to the area of that triangle.

Solution by Norman Anning, Chilliwuck, B. C., and A. M. Harding, Fayetteville, Ark.

Let A_1 and A_2 be the centers of equilateral triangles described outward and inward on the side BC of any triangle ABC.

Similarly B_1, B_2, C_1 and C_2.

In triangle AC_1B_1

$$AC_1=\frac{c}{\sqrt{3}},\ AB_1=\frac{b}{\sqrt{3}},\ \angle C_1AB_1=A+60^\circ.$$
$$B_1C_1^2=\frac{b^2}{3}+\frac{c^2}{3}-\frac{2bc}{3}\cos(A+60^\circ).$$
$$=\frac{b^2}{3}+\frac{c^2}{3}-\frac{2bc}{3}\left(\frac{\cos A-\sqrt{3}\sin A}{2}\right).$$
$$6B_1C_1^2=2b^2+2c^2-2bc\cos A+2bc\sqrt{3}\sin A.$$
$$=a^2+b^2+c^2+4\Delta\sqrt{3} \text{ where } \Delta=\text{area of } \Delta ABC.$$

Since this expression is symmetrical in a, b and c, it follows that triangle $A_1B_1C_1$ is equilateral.

Similarly,

$6B_2C_2^2 = a^2+b^2+c^2-4\Delta\sqrt{3}$ and Δ $A_2B_2C_2$ is equilateral.

$$B_1C_1^2-B_2C_2^2 = \frac{4\Delta\sqrt{3}}{3}.$$

$$B_1C_1^2\frac{\sqrt{3}}{4}-B_2C_2^2\frac{\sqrt{3}}{4}=\frac{4\Delta\sqrt{3}\sqrt{3}}{3\cdot 4} = \Delta.$$

Or $\Delta A_1B_1C_1-\Delta A_2B_2C_2 = \Delta ABC.$

Remark by Editor:

$$6B_1C_1^2 = a^2+b^2+c^2+4\Delta\sqrt{3}.$$
$$6B_2C_2^2 = a^2+b^2+c^2-4\Delta\sqrt{3}.$$
$$\therefore \quad 3(B_1C_1^2+B_2C_2^2) = a^2+b^2+c^2.$$

Hence the sum of the squares of the sides of the two new triangles is equal to the sum of the squares of the sides of the original triangle.

359. *Proposed by H. E. Trefethen, Waterville, Maine.*

Prove that the angle-bisector in any triangle is less than the arithmetic mean of the two adjacent sides.

I. *Solution by Levi S. Shively, Mount Morris, Ill., and G. Yale Sosnow, Newark, N. J.*

Let ABC be the given triangle of which the angle A is bisected by AD. In case AB = AC the truth of the proposition is evident. Let AC>AB. Let E be the midpoint of BC. Draw AE and produce it to F making EF = AE. Draw CF. Since $\angle$B is greater than $\angle$C the supplementary angles at D are unequal and the obtuse one is on the side of AD towards C. Since AB : AC = BD : DC, BD must be less than one-half of BC. Hence E lies between D and C. Therefore, obtuse angle ADE is an interior angle of triangle ADE and AD<AE. But AC+AB = AC+CF>AF, and AE = ½AF. It follows that AD<½(AC+AB).

II. *Solution by A. M. Harding, Fayetteville, Ark.*

Let x = length of bisector of $\angle$ A.

Now $\Delta ABD+\Delta ACD = \Delta ABC$.

$\therefore \frac{1}{2}cx \sin A/2+\frac{1}{2}bx \sin A/2 = \frac{1}{2}bc \sin A = bc \sin A/2 \cos A/2.$

$$\therefore x = \frac{2bc}{b+c}\cos A/2 \text{ and } \therefore\ x<\frac{2bc}{b+c} \leqq \frac{b+c}{2}.$$

III. *Solution by T. M. Blakslee, Ames, Iowa.*

If t, the bisector of angle between a and b, divide the side c into segments m and n,

$$t^2 = ab-mn \quad \text{or} \quad t^2-ab = -mn.$$

Hence t^2-ab is a negative quantity. If $t = \dfrac{a+b}{2}$, $t^2-ab = \left(\dfrac{a-b}{2}\right)^2$ = a positive quantity. $\therefore\ t<\dfrac{a+b}{2}$.

Trigonometry.

360. *Proposed by Nelson L. Roray, Metuchen, N. J.*

If θ be the angle between the diagonals of a parallelogram whose sides a, b are inclined at an angle α to each other, show that

$$\tan\theta = \frac{2ab\sin\alpha}{a^2-b^2}.$$

Solution by M. G. Schucker, Pittsburgh, Pa., and L. E. A. Ling, La Grange, Ill.

Let $2m$, $2n$ be the diagonals and A the area of the parallelogram.

Then $$ab \sin \alpha = A.$$

Also $$2mn \sin \theta = A.$$

$$\therefore \quad \sin \theta = \frac{ab \sin \alpha}{2mn}$$

$$\cos \theta = \frac{m^2+n^2-b^2}{2mn}$$

$$\therefore \quad \tan \theta = \frac{ab \sin \alpha}{m^2+n^2-b^2}$$

$$= \frac{2ab \sin \alpha}{a^2-b^2}.$$

CREDIT FOR SOLUTIONS.

357. Norman Anning, N. Bessho, T. M. Blakslee, D. J. da Silva, Walter C. Eells, A. M. Harding, Selma Koehler, L. E. A. Ling, A. MacNeish, R. M. Mathews, H. C. McMillin, C. A. Perrigo, H. Polish, Harry Roeser, Nelson L. Roray, M. G. Schucker, Elmer Schuyler, Levi S. Shively, G. Yale Sosnow, Fred M. Taylor, Edward R. Wicklund. (21)

358. Norman Anning, A. M. Harding, M. G. Schucker, Nelson L. Roray. (4)

359. Norman Anning, T. M. Blakslee, D. J. da Silva, A. M. Harding, G. I. Hopkins, L. E. A. Ling, H. C. McMillin, M G. Schucker, Elmer Schuyler, Levi S. Shively, G. Yale Sosnow, Harry Roeser, Nelson L. Roray. (13)

360. Norman Anning, T. M. Blakslee, A. M. Harding, Wm. W. Johnson, L. E. A. Ling, A. MacNeish, R. M. Mathews, A. L. McCarty, H. Polish, Harry Roeser, Nelson L. Roray, M. G. Schucker, Elmer Schuyler, Levi S. Shively, Amy N. Trout, Wm. H. Zeigel. (16)

Total number of solutions, 54.

PROBLEMS FOR SOLUTION.

Algebra.

371. *Proposed by Nelson L. Roray, Metuchen, N. J.*

Solve: $$(x^2+y^2)\frac{x}{y} = 6$$

$$(x^2-y^2)\frac{y}{x} = 1$$

(From a recent examination paper.)

372. *Proposed by I. L. Winckler, Cleveland, Ohio.*

The sides of an inscribed quadrilateral are the roots of a given equation of the fourth degree whose roots are all real and positive. Find the area of the quadrilateral, and the radius of the circumscribed circle in terms of the coefficients of the equation.

Geometry.

373. *Proposed by Nelson L. Roray, Metuchen, N. J.*

The altitude of a right circular cone is 40 and the radius of its base is 10. A plane perpendicular to an element intersects the midpoint of the altitude. Find volume of frustrum. (From a recent examination paper.)

374. *Proposed by Philip Fitch, Denver, Colorado.*

To construct a line which shall be the reciprocal of the sum of the reciprocals of three given lines.

375. *Proposed by Elmer Schuyler, Brooklyn, N. Y.*

On the side of a ten inch square two inches from a vertex, a ray of light proceeds at an angle of 30° with longer sect of that side, the path being within the square. When, after reflections at sides of square, it has described a path 25 inches in length it strikes an object. Locate this object with reference to the sides of the square.

SCHOOL ALL THE YEAR ROUND.

A few years ago the idea of school or college all the year round would have been hotly decried; today it is an established fact in a number of educational institutions, public and private. It is not merely that the summer session has been widely introduced, but the summer work, from being a purely voluntary and separate affair, has come in some instances to be an integral part of the year's work, according to reports received at the United States Bureau of Education.

The Harvard Engineering School is a recent instance among higher institutions. The course for the master's degree in engineering at Harvard now takes two years, and there is no summer vacation. The course is divided into first summer, first year, second summer, and second year. The students work from eight to ten hours a day, and the total vacations in a year amount to about four weeks, the time being chiefly at Christmas and in the spring. The summer term begins June 22nd and closes September 22nd. A number of other universities follow a somewhat similar plan. The University of Chicago has for some years maintained a summer term having equal weight with the three other quarters of the year.

Even in the elementary school the plan has made some headway, particularly in the large cities. Cleveland, Ohio, formerly had an all-year schedule which included the summer term as one of four quarters, and a modified form of the Cleveland plan is in use in Newark, N. J., where it is being gradually extended from year to year. In the New York City Schools, where the problem of sufficient school accommodations is a serious one, the authorities have recently had under consideration an all-year plan which will, it is claimed, take care of practically all the children without recourse to half-time. An interesting indication of the attitude of the students themselves toward the all-year plan is afforded by the new Central Commercial and Manual Training High School at Newark. Thirty per cent of the pupils of this school voted in favor of continuing the school throughout the summer.

It is claimed by the advocates of the all-year plan for public schools in the large cities that the children are healthier and happier in school than on the streets. It is further urged that by taking advantage of an optional summer term children who are compelled to leave school at an early age will be able to advance further in the grades than at present. Backward pupils will also have an opportunity to make up back work, but this has always been more or less a feature of summer sessions.

In the case of the higher institutions, particularly the technical schools, the new movement for all-year work is undoubtedly part of the nation-wide demand for scientific efficiency that is making itself felt in every phase of American life. The feeling is that education, especially of an advanced character, is not child's play alone, but serious business, and should approximate the conditions of efficient business.

SCIENCE QUESTIONS.

By Franklin T. Jones,
University School, Cleveland, Ohio.

Readers of School Science and Mathematics *are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.*

Questions and Problems for Solution.

125. *Proposed by E. Carl Watson, Brazil, Ind.*

May the same bolt of lightning strike a building and, at the same time, kill stock in a neighboring field one-half mile distant?

126. *Proposed by H. C. McMillin, Washington, Kansas.*

A man ascending in a balloon drops a stone when on a level with a church spire 128 feet high. The stone reaches the ground in 4 seconds. What is the balloon's vertical velocity?

127. *Proposed by E. Carl Watson, Brazil, Ind.*

When a steady pull is applied to the lower end of a sheet of paper, under what conditions, particularly as to the angle which this line of force makes with the perforated line at the point of rupture above, may one tear the sheet from a perforated tablet?

Assuming the relation between the proximity of the perforations and the strength of paper to be a constant one, when will the paper tear not along a perforated line?

128. *From Hale's Calculations of General Chemistry (Van Nostrand).*

A specimen of silver, containing 3 per cent copper, weighed 9.8 grams. After solution in nitric acid, an excess of sodium chloride was added to it. Calculate the weight of silver chloride precipitated. (Number 163, page 103.)

129. *From Millikan & Gale's Physics (Revised) page 196. (Ginn & Co.)*

It requires a force of 300 kilos to drive a given boat at a speed of 15 knots (25 km.). How much coal will be required to run this boat at this speed across a lake 300 km. wide, the efficiency of the engines being 7 per cent and the coal being of a grade to furnish 6000 calories per gram?

Solutions and Answers.

114. *From an M. I. T. Entrance Examination Paper.*

A lump of ice floats in a vessel of water. How will the height of the water be affected when the ice melts?

There will be no change in the water level because the water formed will weigh the same as the block of ice and the volume of the water from melting will occupy the same volume as that part of the ice which was submerged. (Editor.)

Also solved by A. Bjorkland, Appleton, Wis.

115. *From the same.*

Sixteen small electric lamps are used to light a Christmas tree. Each has a resistance of 12 ohms and requires a current of half an ampere to operate. If they are connected in series, what voltage must be applied? If they are in parallel connected to a battery, what voltage must be applied and what current will flow from the battery?

Solved by A. Bjorkland, Appleton, Wis.

In series—

$C = 16 \times \frac{1}{2} = 8$ amperes.
$R = 16 \times 12 = 192$ ohms. $C = E/R$, hence $E = 1536$ volts. Ans.

In parallel—

$C = \frac{1}{2} \times 16 = 8$ amperes. Ans.
$R = \frac{12}{16} = \frac{3}{4}$ ohms. $C = E/R$, hence $E = 6$ volts, Ans.

116. *Proposed by George Yale Sosnow, Newark, N. J.*

Why does throwing the hands out of water cause the head of a swimmer to be submerged?

Solution by Jno. A. Hodge, Sumner High School, Kansas City, Kans.

When swimming the hands serve as a support for the trunk and head of the swimmer, by the reaction offered when the hands are pressed downward in the water. The hands also displace a certain amount of water, thus causing a buoyancy. Now when the hands are out of the water neither of these supports for the body are operating, hence gravity pulls the head down.

117. *Proposed by G. Y. Sosnow, Newark, N. J.*

The motor of an electric car can develop 200 H. P. With what velocity can the car run against a uniform resistance of 2,200 pounds?

Solution by Stanley T. Baker, High School, Freeport, N. Y.

When the car first starts some of the power will be used to overcome the resistance and some to give acceleration to the car. As the velocity of the car increases more and more of the power will be used to overcome the resistance until finally a point is reached where all the power will be used to overcome the resistance. This will be the maximum velocity. Calculating the velocity for this condition we have:

Let $v =$ the velocity in feet per second.

Then v will $=$ the feet passed over by the car in one second.

If 2,200 pounds $=$ the resisting force,

$2{,}200v =$ the foot-pounds of work done per second.

Now 200 H. P. $= 110{,}000$ foot-pounds per second.

Therefore, $2{,}200v = 110{,}000$.

$v = 50$ feet per second, or 34.0909 miles per hour.

Also solved by J. A. Hodge, Kansas City, Kans.

118. How many cubic centimeters of a hydrochloric acid solution (density 1.1 and containing 20 per cent pure acid by weight) are required to neutralize 100 grams of sodium hydroxide?

Solution by Jno. A. Hodge, Kansas City, Kansas.

The equation for the reaction is $\underset{36.5}{HCl} + \underset{40}{NaOH} \rightarrow NaCl + H_2O$.

Hence 40g. NaOH requires 36.5 HCl.

100g. NaOH requires a proportional amount.

$40 : 36.5 :: 100 : x$.

$40x = 3650$.

$x = 91.25$g. HCl.

$\therefore$ 20% of the solution $=$ 91.25g.

100% of the solution $=$ 456.25g.

$$\text{Volume} = \frac{\text{weight}}{\text{density}} \quad \therefore \text{volume} = \frac{456.25}{1.1} = 414.77 \text{ cm}^3. \text{ Ans.}$$

119. State the principle of Archimedes. A block of ice having a density of 0.917 grams per c.c. is floating on water which has a density of 1.03 grams per c.c. What portion of the block will be immersed and what portion will be exposed?

Solution by C. A. Smith, Payson, Utah.

(a) A body immersed in a liquid is buoyed up by a force equal to the weight of the liquid displaced by it.

Note: (A floating body displaces its own weight of the liquid).

(b) Since the density of the ice is 0.917 gm. per c.c. and that of the ice—1.03, 917/1030 of the block will be immersed, or 0.88, leaving 0.12 exposed.

Also solved by J. A. Hodge, Kansas City, Kansas.

VOCATIONAL EDUCATION.

The movement for vocational education in this country is now in full swing. Six states already have more or less complete systems of vocational training, and a number of others are considering legislation to introduce into the public schools work that will fit boys and girls more directly for earning a living. In order to aid in the movement the National Society for the Promotion of Industrial Education has issued a brief, explicit statement of what it considers the main principles that should underlie the proposed legislation, and the United States Bureau of Education, while not giving official indorsement to the program as a whole, is sending copies of the pamphlets to those who apply for it.

What are the essentials of a state system of practical education? The society's circular endeavors to answer this question. In a few short non-technical paragraphs it sums up certain of the fundamental policies of vocational education as this society sees it. It urges state aid to the local communities. It recognizes four fields of vocational training as the kind the state ought to furnish its boys and girls: Industrial education for workers in the trades and industries and in the household; agricultural education for the farmers; commercial education for clerks, salesmen, etc.; and "household arts education" for non-wage-earning occupations connected with the home. In other words, the state ought to make it possible for children to receive in the public schools instruction that will fit them directly for productive employment in any of these useful occupations, instead of sending them out with little or no training for the real work they are going to do.

Experience has already been sufficient to indicate in what kind of schools this vocational training can be given. The circular cites a number of types of schools, some based on European models, others in American practice, among them the following: The all-day vocational schools, where the pupils can spend at least one year in all-day attendance; the part-time schools, where boys and girls regularly employed may come for a few hours each week; the evening schools in industry or agriculture, for persons over sixteen years of age who work during the day; and similar evening schools or classes in household arts.

It is significant that the six states that have already set up systems of vocational education—Massachusetts, New York, Connecticut, New Jersey, Wisconsin, and Indiana—have long had excellent schools. The newer education which they are introducing is not intended to replace the old, but to supplement it; to give training for a specific employment in addition to the regular schooling, so that the boys and girls may be more efficient and willing workers, as well as better educated individuals.

A RULE TO SQUARE NUMBERS MENTALLY.

By Robert C. Colwell,
Geneva College, Beaver Falls, Pa.

Certain pairs of numbers whose sum is 50 have squares ending with the same digits in the last two places. Thus, $23^2 = 529$, $27^2 = 729$. Hence, the square of a number greater than 25 is connected in a very simple way with the square of a number less than 25.

Example. To obtain the square of 43.

$$\begin{array}{r} 50-43 = 7 \\ \\ 25-7 = 18 \\ 7^2 = 49 \\ \hline 43^2 = 1849 \end{array}$$

To obtain the square of 31.

$$\begin{array}{r} 50-31 = 19 \\ \\ 25-19 = 6 \\ 19^2 = 361 \\ \hline 31^2 = 961 \end{array}$$

Hence the rule. To square any number between 25 and 50 subtract the number from 50 and subtract the result from 25. This second remainder will give the hundreds of the required square. Square the first remainder and add the result to the hundreds, the sum is the required square. No mistake need be made if it is borne in mind that the first difference squared gives units and the second difference gives the hundreds

Any number between 75 and 100 can be squared mentally if it is made to depend upon the nearest hundreds. Thus, numbers from 75 to 150 are made to depend on 100. Numbers from 150 to 250 are made to depend on 200, and so on.

Examples.

1. Square 89. $89 = (100-11)$ $$\begin{array}{r} 11^2 = 121 \\ 89-11 = 78 \\ \hline 7921 \end{array}$$

2. Square 113. $113 = (100+13)$ $$\begin{array}{r} 13^2 = 169 \\ 113+13 = 126 \\ \hline 12769 \end{array}$$

3. Square 198. $(200-2)$ $$\begin{array}{r} 2^2 = 04 \\ 400-8 = 392 \\ \hline 39204 \end{array}$$

4. Square 223. $(200+23)$ $$\begin{array}{r} 23^2 = 529 \\ 400+(4\times 23) = 492 \\ \hline 49729 \end{array}$$

ARTICLES IN CURRENT PERIODICALS.

American Forestry for November; *1410 H. Street, N. W., Washington, D. C.; $2.00 per year, 20 cents a copy:*. "The Fire Protection of the United States Forest Service," Agnes C. Laut; "Development of Fire Protection in the States," J. Girvin Peters; "What Has Been Accomplished in Fire Protection on the National Forests," H. E. Woolley; "Dynamite in Forest Fire Fighting," Warren H. Miller; "The Conservation of Water," Walter McCulloh; "Waste in Cutting Timber," R. C. Bryant; "Water Laws, State and National," Charles N. Chadwick.

American Mathematical Monthly for November; *H. E. Slaught, 5548 Kenwood Ave., Chicago, Ill.; $2.00 per year, 25 cents a copy:* "Number Systems of the North American Indians," W. C. Eells; "Synthetic Projective Geometry as an Undergraduate Study," W. H. Bussey; "A Note on the Solution of Linear Differential Equations," C. R. MacInnes; "A Graphical Solution of the Differential Equation of the First Order," T. R. Running.

Educational Psychology for November; *Warwick and York, Baltimore, Md.; $2.50 per year, 30 cents a copy:* "General Intelligence or 'School Brightness,'" Colin A. Scott; "Experimenatl Researches on Learning to Spell," I, W. H. Winch; "Mental Age Tests," D. F. Carpenter; "The Education of Defectives and the Training of Teachers for Special Classes," E. B. Huey.

Journal of Geography for November; *University of Wisconsin, Madison, Wis.; $1.00 per year, 15 cents a copy:* "On the Position of Geography in British Universities," George G. Chisholm; "The Age of the Earth," W. M. Davis; "Points in the Geography of South America," C. J. Posey; "The Saone-Rhone Valley," Frederick Homburg; "Man and Nature in the Making of Three Great Harbors," K. W. Davidson; "Little Studies in Climate—Frost."

Mathematical Gazette for October; *G. Bell and Sons, Portugal St., Kingsway, London; six no., 9s. per year, 1 s. 6 d. a copy:* "The Edinburgh Mathematical Colloquim," C. G. Knott; "The Teaching of Geometry and Trigonometry" (Concluded), W. J. Dobbs; "Notes on the Radix Method of Calculating Logarithms" (Concluded), Sidney Lupton; "The Simple Pendulum," Prof. D. K. Picken.

National Geographic Magazine for November; *National Geographic Society, Washington, D. C.; $2.50 per year, 25 cents a copy:* "The Non-Christian Peoples of the Philippine Islands" (32 pages of illustrations in eight colors), Dean C. Worchester.

Photo-Era for November; *383 Boylston Street, Boston; $1.50 per year, 15 cents a copy:* "A Study in Backgrounds," Sidney Allan; Negative-Defects, Their Origin and Cure," David J. Cook; Photographic Work on a 25-Foot Motor-boat," Alfred F. Loomis; "The Non-Screen Ortho Plate," E. J. Wall; "The Art of Book-Illustrating," Charles S. Olcott.

Physical Review for November; *Ithaca, N. Y.; $6.00 per year, 60 cents a copy:* "The Vapor Pressure of Metallic Tungsten," Irving Langmuir; "The Infra-Red Optical Properties of Some Sulphides: A Balanced Method of Using the Bolometer," Irving B. Crandall; "The Flow of Air Through Capillary Tubes," I. M. Rapp; "The Longitudinal Thermomagnetic Potential Difference," Alpheus W. Smith; "The Measurement of Magnetic Fields by Their Damping Effect Upon a Vibrating Coil," Paul E. Klopsteg.

Popular Astronomy for December; *Northfield, Minn.; $3.50 per year, 35 cents a copy:* "Some Evidences of a Resisting Medium," Russell Sullivan; "Annual Report of the Section for the Study of Auroræ, the Zodiacal Light and the Gegenschein," Alan P. C. Craig; "Campbell's 'Stellar Motions,'" R. H. Curtiss; "The Cosmoid," John F. Lanneau.

Psychological Clinic for November; *Woodland Ave. and 36 St. Philadelphia; $1.50 per year, 20 cents a copy:* "Measuring Efficiency of Instruction," William E. Grady; "A Little More 'Truth About Tobacco,'" Charles K. Taylor; "Retarded Sixth Grade Pupils," Anna Johnson; "What is Sanity?" Alice Groff.

School Review for December; *University of Chicago Press; $1.50 per*

year, 20 cents a copy: "Some Vital Statistics of Children of School Age," Frederick L. Hoffman; "An Experiment in the Supervised Study of Mathematics," J. H. Minnick; "The Study of French in the Public High Schools of the United States," Frederic Locard; "Tobacco and Scholarship," Thomas Warrington Gosling.

Unterrichtsblätter für Mathematik und Naturwissenschaften, Nr. 7; *Otto Salle, Berlin, W, 57, Germany; 4 M. per year 60 pf. a copy:* "Die Veranschaulichung von veränderlichen Figuren im Unterricht," Prof. H. Detlefs; "Zur Einführung in die Elemente der Differential—und Integralrechnung auf den höheren Schulen," Prof. Dr. Pyrkosch; "Zur Konstruktion der Ellipse aus zwei Punkten, aus dem Mittelpunkt und der Länge der grossen Achse," Dr. Karl Wörner; "Die Löslichkeit von Ozon in Wasser," Otto Bürger.

Zeitschrift für Mathematischen und Naturwissenschaftlichen Unterricht for October; *B. G. Teubner, Leipzig; 12 numbers, 12 M:* "Versuch einer Gruppierung der neueren mathematisch-historischen Schriften (1887-1911)," Felix Müller; "Die Kleinsche Einführung des Logarithmus," C. F. B. Funk; "Zur Konstruktion konjugierter Durchmesser eines beliebigen Kegelschnittes," Prof. Diesing; "Aufgaben über Stellungen der Uhrzeiger, Eine Stunde in Obertertia," Prof. Chr. Lenhardt; "Zur graphischen Lösung kubischer Gleichungen," Wilh. Effenberger; "Zur Geometrographie," edited by K. Hagge.

PSYCHOLOGY AND JOBS.

Are you looking for a job as motorman? Prove your ability by psychology. Will you make a good chauffeur? Submit to a mental test and find out. Would you be a successful telephone operator? You will save the company's time and your own by undergoing a psychological examination to determine your fitness for the position. Psychology plays a prominent part in the various plans for vocational guidance currently reported to the United States Bureau of Education, by means of which scientists hope to devise ways of measuring people with regard to their qualifications for certain kinds of work.

Dr. Leonard P. Ayres, of the Sage Foundation, has just summed up a number of psychological tests for positions actually put into practice in modern industry. Thus the American Telephone and Telegraph Company engaged Prof. Munsterberg to introduce a test for determining which applicants were likely to prove good telephone operators. The girls were examined with reference to "memory, attention, general intelligence, space perception, rapidity of movement, accuracy of movement, and association." The results showed that the girls who qualified in the tests were the most efficient in practical service, while those who stood at the foot of the list failed later and left the company's employ.

Prof. Munsterberg has also tested street-car motormen by elaborate apparatus, with a view to selecting those least likely to be responsible for accidents. As a result of his experiments he came to the significant conclusion that the application of such a test on motormen would result in the rejection of about 25 per cent of those now employed.

Mr. S. E. Thompson used "reaction-time tests" in selecting girls for the work of inspecting for flaws in the steel balls used in ball bearings. The final outcome was that 35 girls did the work formerly done by 120; the accuracy of the work was increased by 66 per cent; the girls' wages were doubled; the working day decreased from $10\frac{1}{2}$ hours to $8\frac{1}{2}$ hours; and the profits of the factory increased.

Another set of psychological tests aims to select positions for persons, rather than persons for positions, but not much has really been done in this field. The difficulties in the way of both kinds of tests may be in-

ferred from the fact that there are something like 10,000 separate kinds of gainful occupations in the United States.

Dr. Ayres sees great possibilities in psychological tests for choosing the right persons for jobs. He says: "When the best possible adjustment shall have been attained between work and workmen, each one will have his full opportunity to achieve at least something for commonwealth and commonweal. The task of the world will be better done and the workers will receive greater rewards, deeper joy, and fuller satisfaction in their doing."

CANAL COMMISSION SEEKS GENUINE GREENHEART.

Clayton D. Mell of the United States forest service has sailed from New York for British Guiana to inspect greenheart timber to be used in the construction of docks and other marine works for the Panama Canal. He goes at the request of the Isthmian canal commission, in order that the engineers may be sure that they are getting genuine greenheart timber, for which a number of inferior substitutes are offiered.

Genuine greenheart has the reputation of being the most resistant wood to the attack of marine borers and to decay. Borers are especially bad in tropical waters. The wood is, in addition, hard, heavy, and durable, and not subject to damage from impact and wear. Indisputable records show that the best grades of this wood surpass iron and steel as to lasting qualities in contact with salt water. It has been known and used since 1769. Logs have remained intact under water for 100 years. Lock gates in English canals have been made of it for years, and the only limit of their durability so far has been the length of service of their iron bolts and fastenings, which usually can be renewed without much trouble. Greenheart in Liverpool lock gates built in 1856, removed to allow a deepening and widening of the ship channel in 1894, was used over again when the gates were reconstructed. The sills and fenders of the lock gates at Panama will be made of greenheart, and much of the docks will be constructed of the same material.

Nansen's ship, the Fram, and the antarctic vessels, Discovery, used by one of the Scott expeditions, and the Gauss, used by Drygalski, were all planked with greenheart.

The exceedingly great durability of the wood is said to be due, at least in part, to the presence of an alkaloid, which is used as a substitute for cinchona, the basis of quinine.

A number of other woods which grow with greenheart in the tropical forests of the Guianas resemble it so closely that they are likely to deceive even an expert. They have many of the qualities of the genuine timber, but in a lesser degree. Some are quite inferior, and it is essential that they should be avoided. In order that the canal commission may be sure of the right wood, it asked the forest service to assist it in an investigation of the greenheart situation in British Guiana, and Mr. Mell's present trip is a result of that request.

From the Isthmus of Panama, Mr. Mell will go directly to Demerara, British Guiana, the principal port of export for greenheart. He will be accompanied by a member of the commission, and will see all the operations of lumbering in order that the true greenheart may be selected and identified without possibility of error. He will ascertain where the genuine can be obtained in sufficient quantities and right sizes, find out what substitutes are to be avoided, and prepare specifications which, incorporated in purchase contracts, will eliminate everything but genuine greenheart.

OPPOSITION TO STONE TOPS FOR LABORATORY AND LECTURE ROOM TABLES.

There has recently been fostered upon physics teachers, especially, an influence tending to induce them to use and have them recommend to others the use of soapstone as a top for their laboratory and lecture room tables. One can hardly conceive of a material more unfit for the purpose. No real physics teacher or any one thoroughly qualified to manage a secondary school physics laboratory has ever put his sanction upon its use.

At the recent meeting of the Central Association of Science and Mathematics Teachers held at Des Moines, Iowa, the following resolution was unanimously passed, both in the general meeting and in the physics section.

"Resolved, That the Central Association of Science and Mathematics Teachers, in annual meeting assembled, at Des Moines, Iowa, do unhesitatingly, in the strongest terms, condemn the use of soapstone or other mineral material as a substitute for wood on physics or biology laboratory and lecture room table tops. The soapstone is too soft, easily becomes scratched, thus rendering it unfit to be used as a writing desk; it is more expensive than wood; uprights and framework cannot be easily fastened to it; it is easily broken and being a good conductor of heat always feels cold, especially in winter, to the touch.

"It is recommended that a top of hard wood be used, made up of narrow strips, glued together, and wide and long enough to project at least three inches over the rail on all sides."

The only change to the above resolution as far as the physics section was concerned was the introduction of the words "physics section of the" just before the word Central, and the omission of the words "or biology." A resolution of the character of this one was unanimously passed, a few days ago, in a meeting of the physics teachers of Chicago.

This Journal desires to be placed on record as opposing the use of mineral material of any kind for table tops in secondary school physics laboratories. It speaks from information gathered from hundreds of college and secondary school instructors who are thoroughly competent to judge, in fact are experts and the only persons whose judgment should be considered in the matter. There is no material superior to hard wood for the purpose.

THE COMMON TOWEL.

This household infection spreader is abhorrent and repulsive to a person who has been used to an individual towel. It is difficult to understand how any one can wipe his face on a soiled, damp towel that has been used by all the other members of the household. But custom is a great factor in molding habits and allaying prejudices, hence the necessity of pointing out at least one reason why the common towel is dangerous. There are many germs which will attack the eyes and cause inflammation, providing the eyes are in a favorable condition for the germ to develop at the time of its introduction. A germ which at one time will grow in the eye and cause inflammation will at another time be perfectly harmless. Germs which are harmless to oneself may be exceedingly poisonous to another person and cause dangerous inflammation of the eyes. For hygienic reasons the common towel should be abolished in every home.

A DEVICE IN THE TEACHING OF TOPOGRAPHIC MAPS.

By William Harmon Norton,
Cornell College, Iowa.

Teachers of laboratory physiography may be interested in a little device designed to meet some initial difficulties in the use of topographic maps. We perhaps expect the beginner to give us a written description of the area studied—a translation into passable English from the foreign language of contours and other conventional signs. But his topographic vocabulary is limited, he has no pattern or model for his work, and though he may be guided by questions, his attitude is apt to be very like that of the Children of Israel in the strawless brick-yards of Egypt.

As a help to the first stumbling steps I have been using a device suggested by that form of the examination question—which is not a question at all but a declarative sentence with some words or phrases left to be filled in by the pupil—a form which is certainly a time saver for pupil and teacher, whatever its demerits may be. Our beginners in the physiographic laboratory of Cornell College, in their first few map studies, are furnished with descriptions of the areas, printed on their note-book paper—descriptions with many blanks to be filled in from their investigations of the maps. This serves as an outline and question-set and somewhat as a pattern for their later work on other quadrangles. It also enables the teacher to introduce easily valuable material not discoverable from the map, if he considers it good pedagogy to do so. By concentrating the attention, and by relieving from mechanical pen work, the device saves at least twenty-five per cent of the pupils' time.

An example, somewhat abridged, will illustrate the merits and demerits of the plan. The blanks have been filled *in italics* with such words and phrases as the pupil can supply, or with such as may be suggested in the class discussion.

Portage Quadrangle.

The Portage quadrangle lies in the *south central* part of Wisconsin. The lowest points are found where the *Wisconsin*, the *Fox* and the *Grand* rivers leave the quadrangle at an elevation of *about 780* feet above sea level. The highest point is *Observatory* Hill, *1100* feet A. T. The maximum relief is thus *320* feet.

Drainage. The prevalence of *lakes* and *swamps* marks a sluggish, and impeded and undeveloped drainage. The proportion of undrained land reaches *37* per cent of the total area.[1] The longest continuous belt of marsh is that through which the Fox river takes its way, extending from *Pardeeville in the southeastern township to the northwestern corner of the quadrangle*. In the distance of *23* miles the marsh descends *little more than 20* feet. In width it varies from *a quarter of a mile* to *one and one-half and two* miles. Tributary marshes join this axial mash; that of Spring Brook is *9* miles long and that of Neenah Creek is *two and one-half* miles in width. These numerous marshes so connect as to enclose insular areas of upland, as is seen in *almost every* township.

In the marsh lands are found numerous lakes connected by creeks with the rivers. The largest lakes of the area are formed by expansions of the *Fox* river. They are *elongate* in shape, and the largest, *Buffalo* Lake, reaches a length of *five* miles. They occupy depressions as yet unfilled by *silt* and *vegetation* and their depth is evidently *shallow.*

The course of the Fox river has already been described by the de-

[1] Easily found by having one of the class weigh the map (trimmed) and then cut out and weigh the lake and marsh areas.

scription of the marshy belt through which it flows. Grand River, a tributary of the Fox, crosses *the northeastern section* of the quadrangle with inosculating channels. Wisconsin river and its tributary, Baraboo river, flow in a *southeasterly* direction across the *southwestern portion of the area.*

The Wisconsin and the Grand, as well as the Fox river, flow through wide belts of marsh land. The marshes of the three rivers are not separated by upland divides, but coalesce in a continuous swamp. If this were slightly inundated it could be traversed by a boat from *the northeastern corner of the area to the northwestern and thence to the southwestern corner. Every township of the quadrangle could then be visited.*

At high water the Wisconsin now discharges some of its flood waters into the Fox river.

The Fox and the Wisconsin rivers have scarcely begun to excavate valleys below the level of the marsh lands through which they take their ways. When they actively begin the work of erosion it is improbable that the two streams will deepen their valleys at Portage at the same rate. If the channel of the larger river, *the Wisconsin,* is more rapidly deepened than that of the *Fox* river, the following consequences will ensue: *Gullies working back by head erosion from the Wisconsin at Portage will reach the channel of the Fox river and capture its headwaters. The divide between the two rivers will thus be shifted to the marsh lands of the Fox river valley north of Portage.*

The Uplands. From the level of the marsh lands, which are found in every township, rise uplands whose lower portions are formed of glacial drift and whose higher knobs and detached ridges are, for the most part, the erosion remnants of ancient horizontal strata which once extended over the entire area. The bases of the knobs are *elliptical* in shape; the direction of their long axes is *various;* their sides are steep. The highest rises *200* feet above the gentle slopes about its base.

The relief of the quadrangle is due to unequal erosion in a former cycle, and to unequal deposit of glacial drift which marked the beginning of the present cycle. The Wisconsin ice sheet moved from east-north-east over the area, and its terminal moraine is situated but a few miles to the west. The area is in the stage of topographic *infancy.* This is shown by *the wide marshes yet undrained, the numerous lakes not yet effaced, the low swampy divides between the rivers, and by the fact that the rivers and creeks have scarcely begun their work of valley excavation.*

Culture. The marshes of the area seriously lessen its value for *agricultural* purposes.

Some of the swamps may have an economic value because of the deposits of *peat* which may be supposed to underlie them. For plow land the sides of the knobs and ridges have *least* value, because of their *steep slope.* The most valuable agricultural land at present as shown by the density of population is *that of the gently sloping uplands.*

The city of Portage takes its name and derives its advantage of situation from *the portage between Wisconsin and Fox rivers.* The Fox and Wisconsin rivers are here connected by a *canal,* so that it is possible for a small boat to pass from *Lake Michigan* to *the Mississippi river.*

Up the Fox river, with its border of wild rice swamps, came in June, 1673, two birch-bark canoes bearing the famous French explorers, Joliet and Marquette, on their way from Quebec to the unknown West. Crossing the portage of our map they embarked on the Wisconsin, and a few days later swung out upon the broad Mississippi nearly opposite the site of McGregor, Iowa.

ENFORCING THE MIGRATORY BIRD REGULATIONS.

Following the proclamation of the President of the United States establishing regulations for the protection of migratory birds, the Department of Agriculture set in motion machinery which made these regulations effective in every state on November 1, 1913, the date set for the operation of the proclamation. These regulations put under Federal protection, for the first time, a large number of migratory game and insectivorous birds and thus places Federal restrictions on the five million hunters of the United States. In enforcing these regulations Federal authorities will co-operate with state game commissioners and other state authorities in carrying out the provisions of the law and to prevent complications in the local enforcement of the regulations.

The states have been grouped into thirteen units or districts, each in charge of an inspector. Several of these positions in the West will be filled temporarily by regular experienced employees of the Department. The work of organizing will probably be begun in the Middle States, the Northwest, and the Pacific Coast. The Department expects to have the assistance of the game commission deputies in the states as well as the public generally and sportsmen in particular who are interested in the success of the new law.

Among the birds protected by the regulations are the brant, wild duck, goose, swan, cranes of various species, rail, several kinds of shore birds, pigeon, dove, wild pigeon, bobolink, catbird, chickadee, cuckoo, flicker, flycatcher, grosbeak, humming bird, kinglet, martin, meadow lark, night hawk, nuthatches, oriole, robin, shrike, swallow, swift, thrush, warbler, whippoorwill, woodpecker, and wren.

The regulations for the enforcement of the law separate the country into two zones known as the breeding and wintering zones. The former comprises twenty-five states lying wholly or in part north of latitude 40° and the Ohio river, and the latter comprises twenty-three states and the District of Columbia lying wholly or in part south of latitude 40° and the Ohio river.

A close season has been established on the catbird, chickadee, grosbeak, humming bird, martin, meadow lark, bullbat, robin, swallow, thrush, whippoorwill, and woodpecker. The regulations contain a prohibition abolishing the hunting of all migratory, game, and insectivorous birds from sunset to sunrise. In Maryland, District of Columbia, Virginia, and South Carolina the close season for the reedbird extends from November 1st to August 31st.

A close season until September 1, 1918, is established on such migratory game birds as the band-tailed pigeon, the little brown sandhill whooping crane, swan and curlew and on all shore birds except the black-breasted and golden plover, Wilson or jack snipe, woodcock, and yellow-legs. A close season until the same date is also established on wood ducks in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, West Virginia, Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Kentucky, California, Oregon, and Washington; on rails in California and Vermont; and on woodcock in Illinois and Missouri.

A close season has been likewise put in force on all migratory birds passing over or at rest on any of the waters of the main streams of the Mississippi river between Minneapolis and Memphis and on the Missouri river between Bismarck and Nebraska City. The killing or capture of any such birds on the shores or from any boat or floating object along these streams is prohibited.

The general open season for waterfowl in the Northern Zone is from

September 1st to December 16th and in the Southern Zone from November 1st to January 16th. Massachusetts has a close season on waterfowl from January 1st to September 15th; New York, excepting Long Island, from December 16th to September 16th; Long Island, Oregon, and Washington from January 16th to October 1st; New Jersey from February 1st to November 1st; Minnesota, North and South Dakota, and Wisconsin from December 1st to September 7th; Deleware, Maryland, Virginia, North Carolina, Alabama, Mississippi, Louisiana, and Texas from February 1st to November 1st; District of Columbia, Kansas, New Mexico, and West Virginia from December 16th to September 1st; Florida, Georgia and South Carolina from February 16th to September 1st; Florida, Georgia, and South Carolina from February 16th to November 20th; Missouri and Nevada from January 1st to September 15th, and Arizona and California from February 1st to October 15th.

The open season on rails, coots, and gallinules is from September 1st to December 1st. Shooting is prohibited in New Hampshire, Rhode Island, and Massachusetts from December 1st to August 15th; Connecticut, Michigan, and New York from December 1st to September 16th; Minnesota, North and South Dakota, and Wisconsin from December 1st to September 17th, Oregon and Washington from January 16th to October 1st; Tennessee and Utah from December 1st to October 1st; Missouri from January 1st to September 15th, Louisiana from February 1st to November 1st; and Arizona and California from February 1st to October 15th.

The open season for woodcock in the North is October and November, and in the South, November and December. Shooting is prohibited in Connecticut, Massachusetts, and New Jersey from December 1st to October 10th; Rhode Island from December 1st to November 1st; Pennsylvania and Long Island from December 1st to October 15th; Delaware and Louisiana from January 1st to November 15th; West Virginia from December 1st to October 1st; and Georgia from January 1st to December 1st.

The season for shore birds is September 1st to December 16th. Killing of shore birds is prohibited in Maine, Massachusetts, New Hampshire, Rhode Island, and Long Island from December 1st to August 15th; in New Jersey from December 1st to September 16th; Minnesota, North and South Dakota, and Wisconsin from December 1st to September 7th; Oregon and Washington from December 1st to October 1st; Florida, Georgia and South Carolina from February 1st to November 20th; Alabama, Louisiana, Mississippi and Texas from February 1st to November 1st; Tennessee from December 16th to October 1st; Arizona and California from February 1st to October 15th; and Utah from December 16th to October 1st, where it is also forbidden to shoot yellowlegs until September 1, 1918.

PEAT FUEL FOR LOCOMOTIVES.

It has recently been announced that a Swedish engineer has perfected a process for utilizing peat powder as a fuel for locomotives. It is reported that a number of Swedish railways are preparing to use this fuel instead of coal, and that they have purchased extensive peat bogs, with which Sweden is plentifully supplied. The claim is made that, result for result, 1.5 tons of peat powder equal one ton of coal. The powder is fed into the furnace by an automatic process.

MUSHROOM FALLACIES.

Mushroom poisoning seems to be an inevitable accompaniment of the summer season. There is a popular tendency to restrict the name "toadstool" to poisonous species and that of "mushroom" to the edible ones; but since one cannot tell, except by trial, whether a particular "toadstool" is poisonous or not, the distinction, according to *The Journal of the American Medical Association,* is neither satisfactory nor advantageous.

Many reputed tests to distinguish the innocent from the harmful toadstool are current and are implicitly believed in by some. It cannot be too emphatically stated, therefore, that so far as is known there is no single guide, with the possible exception of a chemical analysis, which will give results of any value whatever. Any scheme for distinguishing edibility in these fungi should be decisive and give uniform results. Some of the alleged tests deserve mention in order to point out their unreliability and their danger. Among them the so-called "silver-test" is most prevalent. It is believed that a silver spoon or coin placed with toadstools while cooking will demonstrate by blackening, or failure to blacken, whether or not the fungi are safe to eat. It need only be said that there are both poisonous and non-toxic species which act alike on silver. Again, no reliance is to be placed on the contention that if the outer (upper) skin of the top of the toadstool peels off readily, such a species is edible. Some poisonous species also will "peel." Flavor has often been alleged to serve as a reliable guide to edibility, the bitter or peppery species being charged with detrimental attributes. Experience shows, however, that the most poisonous toadstools are not at all disagreeable in respect to the flavor of the raw tissues. Other "tests" are the alleged telltale color changes that are supposed to appear when toxic mushrooms are bruised or broken; or the existence of a milky juice, or the susceptibility of the fungi to the invasion of insects, which are believed to avoid the pernicious varieties. None of these "tests" can be applied with any certainty. As the "proof of the pudding is in the eating thereof," so the surest way of learning to distinguish the poisonous from the innocuous mushrooms is by eating them—a heroic procedure—or by learning the experience of others. There is no royal road to mushroom knowledge, but one must learn to know the various species as one learns to recognize the familiar plants of the forest, the field and the garden.

To those who cherish the hope that the mushroom, often proclaimed as the vegetable beefsteak which Nature lavishly offers at every hand, may solve some of the problems of economy in nutrition, we can give little comfort; for as has been pointed out before, even the most nutritious mushrooms are of little real nutritive value. Their chief claim to dietetic recognition lies in their use as food accessories and dietary condiments. In no wise can they be regarded as a substitute for the substantial meats or the familiar vegetable products ordinarily consumed by man.

TEACHERS AND THE COST OF LIVING.

Most of the teachers in the United States have in effect had their salaries reduced since 1897. Despite an apparent increase in money received, the high cost of living has cut into their salaries just as definitely as if a school board had sliced them. A teaching position which paid $600 salary in 1897 is paying in purchasing power the equivalent of about $416 today, if measured by 1897 prices; the teacher on the $1,000 salary gets no more for his money today than he would have procured fifteen years ago for $693. This is what the high cost of living has done to teachers and others

on a fixed salary schedule, according to a report on teachers' salaries and cost of living distributed by the United States Bureau of Education.

Dr. Robert C. Brooks, executive secretary for the N. E. A. committee, which prepared the report, shows by Bureau of Labor figures that wholesale prices in 1911 were 44.1 per cent higher than in 1907; that retail prices had increased 50.2 per cent in the same period; while in June, 1912, retail food prices were 61.7 per cent higher than in 1896. With these figures as a basis he analyzes teachers' salaries in five cities in different parts of the United States and demonstrates the plight of the teachers in the problem of increased cost of living.

According to the Brooks' report, teachers do not receive enough salary, even in the cities, to save money to carry adequate life insurance or to proceed with further professional training. Out of the 1,600 teachers investigated, only thirteen were found who possessed property over $15,000, and practically every one of these thirteen owed their good fortune to sourcs other than their salaries of teachers. Nearly all of the men teachers carried life insurance, but few of them to a sufficient amount. Only four out of 138 married teachers would, if they were to die now, leave in insurance or any other property as much as ten times their annual salary —the lowest sum that might be expected to provide for the family.

How the high cost of living affects particularly the teacher who seeks to marry and have a home is strikingly demonstrated. In Denver, a city of relatively high salaries, fourteen married women with no others dependent upon them had an average salary of $1,212 to meet their own needs exclusively; sixteen unmarried women with others dependent upon them had an average from salary of $801 to spend on each adult person in the family including themselves; but the married men teachers had an average from salary of only $413 for the equivalent of each adult person including themselves.

Teachers spend more than workingmen for some things, though their pay is about the same. Rent and clothing are bigger items in the teacher's budget than in the laboror's, indicating more exacting community demands. Teachers also spend relatively more than workingmen for life insurance, religious purposes, charity, amusement, vacations, and care of health. They spend less for children's clothing—having fewer children. Not all of them economize in this way, however. "I believe," writes a Denver principal, "that teachers should attend concerts and good plays and take trips; so does my wife, but my salary necessitates a choice between these things and raising a family. We chose the latter."

Many other significant side lights on the high cost of living, particularly as it affects teachers, are brought out in the report on "Teachers' Salaries and Cost of Living." The Commissioner of Education at Washington has a limited number of copies of the report for free distribution.

The little island of Porto Rico has one peak, according to the United States Geological Survey, which is 3,532 feet in height. This is the highest point in the Luquillo Mountains.

For a state possessing no seaboard, Arizona has a wider range of altitude than may be generally supposed. The highest point is San Francisco Peak, 12,611 feet above the sea, and the lowest point is on Colorado River at Yuma, where the elevation is but 100 feet.

A CURIOUS PHENOMENON.

The following account of a very interesting phenomenon has been sent to us by Professor G. E. Ripley of the University of Arkansas, who states that, on the 1st day of November, 1913, a student, while on the way to the laboratory, happened to see a small rainbow near the zenith. The conditions were as follows:

"The time was 10 a. m. The sky was almost free from clouds and especially between the sun and this bow. The bow was between the sun and the zenith, making an angle of about 10 or 15 degrees with the latter. The convex side was to the sun and the arc was about 30 degrees with the center close to the zenith as near as could be judged. It was like an ordinary bow in that the red color was outside and the violet inside. Had the circle been complete, it would have had a diameter about equal to sixty diameters of the moon as it looks when full in the heavens. However, this is only an approximation."

Several persons saw the bow. There may have been some cirrus clouds somewhere which helped produce it. There had been no rain for some time. The bow remained for about one-half hour after it was first seen and did not change its position appreciably.

Have any of our readers ever seen just such a phenomenon and will they give an explanation of it?

EDUCATION IN SEX HYGIENE.

Recognition of their responsibility has resulted in a marked awakening of physicians to their obligations as leaders and teachers in the science of keeping well. The essence of preventive medicine is education, and physicians, by virtue of their training, experience and ideals, ought to be leaders and teachers. Yet until within a few years their responsibilities were not recognized in the prevention of venereal disease and education in the hygiene of sex.

The earlier policy of silence and repression in regard to these matters is fast changing not only on our part but on the part of parents and educators. The sinister menace of venereal disease can hardly be overestimated. In the United States 770,000 males reach early maturity annually. At least 60 per cent, or 450,000 of these young men, will at some time become infected with venereal disease, 20 per cent before the age of 22, 50 per cent before 25, and over 80 per cent before they pass 30. This is the morbidity among males reaching 16 in any one year. Each succeeding year adds a similar group to the aggregate.

Syphilis and gonorrhea undoubtedly surpass in prevalence all other infectious diseases combined, and their immediate and disabling effects fall most heavily on the most active and productive period of life. Gonococcus infection alone is responsible for 80 per cent of all deaths from inflammatory diseases peculiar to women, 75 per cent of all special operations on women, and over 60 per cent of all work done by gynecologists; 50 per cent or more of these infected women are left irremediably sterile besides the number whose offspring are still-born, premature, weakly, diseased or mentally defective.

Considering the terrible ravages of these diseases and their wide prevalence, our efforts at preventive measures have been woefully inadequate, says *The Journal of the American Medical Association*. The community and state assume immense burdens in the care of victims of such conditions as deaf-mutism, mental defectiveness, general paralysis, blindness and many others. Yet the prevention of a large percentage of these conditions by prevention of syphilis and gonorrhea receives but meager at-

tention. If bubonic plague had but a fractional percentage of the incidence of these diseases all hands would be joined to drive it out. Cholera in a civilized country today is no such social and national menace as venereal disease. We appropriate great sums to fight certain epidemic diseases and to maintain a rigid quarantine against them, but we are only now beginning to wage warfare against diseases which are as dangerous as any epidemic disease and far more dangerous than many.

There are various points of attack in this problem and various closely related problems. But there is one point of attack in combating the spread of venereal disease which is justly regarded by many experienced workers as the most vital and strategic, and this is the education of the young. There has been an upheaval in pedagogic and social sentiment in the last few years regarding the question of sex-teaching in home, school and college. Conventional prejudice against such teaching is giving way rapidly, and results are already beginning to appear. Educators are coming to believe that these subjects have a rational and vital place in the educational system.

PROFESSIONAL DISTRIBUTION OF UNIVERSITY AND COLLEGE GRADUATES.

The original purpose of American colleges was mainly to train men for the ministry, but so it is no longer. Harvard, founded chiefly to educate clergymen, now gives to this profession barely two per cent of her graduates; Yale, begun under similar impulses, now contributes a meager three per cent. This and other interesting changes in the professions favored by college graduates are described in a bulletin by Bailey B. Burritt on "Professional Distribution of University and College Graduates," just issued by the United States Bureau of Education.

The decline in the numbers going into the ministry has been accompanied by a rise in the professions of teaching, law, and business. All three have been more or less consistent gainers at the expense of the ministry.

When the older colleges were established boys who expected to be the business men of the community rarely gave much thought to "higher education," That was for the "learned professions," most often, in the early days, the ministry. It is only of recent years that men with business careers ahead of them have taken advantage of college opportunities.

At Harvard the ministry yielded the leadership to law after the Revoluntionary War, and law remained the dominant profession of Harvard graduates until 1880, when business took the lead. At Yale the ministry competed successfully with law until after the middle of the nineteenth century, when law took the ascendency and kept it until 1895, being then displaced by business. At the University of Pennsylvania one-fourth of the graduates used to go into the ministry; now about one-fiftieth do so. Oberlin College, founded with strong denominational tendencies, shows the same story of the decline in numbers of men going into the ministry. At the University of Michigan, out of an army of over 15,000 graduates, only 188 have become ministers.

Aside from their contributions to the clergy, most of the universities and colleges have had favorite professions. At Columbia, Dartmouth, and Michigan, for instance, it is law; at Pennsylvania it is medicine; at Oberlin, Wisconsin, and many others, particularly the co-educational institutions, it is teaching; while a few of the universities, Brown, for example, have shown an impartial spirit, dividing up their strength almost equally among four leading professions.

A final summary of thirty-seven representative colleges shows that teaching is now the dominant profession of college graduates, with twenty-five per cent; business takes twenty per cent; law, which took one-third of all the graduates at the beginning of the nineteenth century, now claims but fifteen per cent; medicine takes between six and seven per cent, and seems to be slightly on the decline; engineering is slowly going up, but still takes only three or four per cent; while the ministry, with its present five or six per cent of the total, has reached the lowest mark for that profession in the two and a half centuries of American college history.

CLEAN HANDS.

The assertion is sometimes made that it is alone the "filthy habits" of the typhoid carrier that make him a public danger. If he could be made to wash his hands, it is alleged, transference of infection would be prevented. Those who regard bacterial cleanliness as simply a matter of careful hand-washing are likely to obtain disappointing results if a recent experiment performed by Cummins is at all indicative of what may occur under ordinary conditions of life. This observer, after dipping the right index-finger in a solution containing typhoid bacilli, proceeded to carry out measures of cleansing as follows:

1. Rinsed in cresol solution. 2. Then held the finger under the tap, rinsing first in cold, then in very hot water. 3. Washed very carefully in about 0.5 c.c. of sterile water, in a watch-glass, and plated the whole of the water used for this purpose Result: Three hundred and thirteen colonies of *Bacillus typhosus* on the plate. 4. After the washing in sterile water mentioned, the tip of the finger was thoroughly soaked in absolute alcohol, allowed to dry, and the washing in sterile water repeated. The "washings" were again "plated." Result: Four colonies of *B. typhosus.*

Even when the fingers are thoroughly rubbed with a towel and the danger of finger infection thereby lessened, it is obvious that the towel in its turn may become infected. The sort of accident that may follow from such conditions is illustrated by another observation of the same author:

On September 26, 1912, 100 c. c. of soup freshly prepared from the "stock pot" was placed in a china bowl, no attempt being made to sterilize the bowl or to cover it from the air. The tip of the experimenter's right index-finger was allowed to come in contact with a solution containing typhoid bacilli. The china bowl was then lifted in such a manner that the infected finger came in contact for a moment with the contained soup. The soup was left at room temperature with free access of air and dust to the open bowl. Bacterial examination showed that typhoid bacilli were present apparently in pure culture, numbering 15,500 per cubic centimeter.

Such facts as these, says *The Journal of the American Medical Association,* add strength to the agitation for better supervision over the conditions of those persons engaged in serving and preparing food for large numbers of people. The action of the Pennsylvania Railroad in providing for the systematic inspection of all of its employees in the restaurant and dining-car systems has already been noted. This example should be followed by the managements of other organizations engaged in the handling and serving of food on a large scale. Social clubs and similar bodies, as pointed out by a correspondent, recently, are often lax in this regard. The supervision of cooks and waiters in dining-cars, hotels, restaurants and clubs is certainly a matter that deserves more attention than it has yet received. "Defective plumbing" is far less important.

BOOKS RECEIVED.

Experimental Wireless Stations, by Philip E. Edelman. 224 pages. 12x20 cm. Cloth. 1914. $1.50. Published by the Author, Minneapolis, Minn.

A System of Questions and Problems in Chemistry, by Floyd L. Darrow, Polytechnic Preparatory School, Brooklyn, N. Y. 128 pages. 13x20 cm. Paper. 1913. 40 cents. F. L. Darrow, 99 Livingston St., Brooklyn, N. Y.

Laboratory Manual and Notebook in Botany, by Willard N. Clute, Flower Technical High School, Chicago. 70 pages+blank pages. 21x27 cm. Paper. 1913. 50 cents. Ginn and Company, Boston.

Bacteria in Relation to Country Life, by Jacob G. Lipman, Rutgers College. Pages xx+486. 13x19 cm. Cloth. $1.50. The Macmillan Company, New York City.

Guide to the Study of Animal Ecology, by Charles C. Adams, University of Illinois. Pages xii+183. 13x19 cm. Cloth. 1913. The Macmillan Company, New York City.

Constructive Text-Book of Practical Mathematics, by Horace W. Mouh, Pratt Institute. Pages xvii+428. 14x20.5 cm. Cloth. 1913. $2.00 net. John Wiley and Sons, New York City.

Personal Hygiene, by Dr. Frank Overton. 240 pages. 13x19 cm. Cloth. 1913. American Book Company, New York City.

Analytic Geometry and Principles of Algebra, by Alexander Ziwet and Louis A. Hopkins, University of Michigan. Pages viii+369. 13x19 cm. Cloth. 1913. $1.60. The Macmillan Company, New York City.

A Text-Book on Spherical Trigonometry, by Robert E. Moritz. Pages vi+67. 15x23 cm. Cloth. 1913. $1.00 net. John Wiley and Sons, New York City.

Electrical Measurements in Direct and Alternating Current, by W. H. Timbie, Wentworth Institute. 50 exercises. 20x26.5 cm. Paper. 1913. 85 cents net.

Exercises in Mechanics, by J. M. Jameson, Girard College. 52 exercises. 20x26.5 cm. Paper. 1913. 85 cents net.

Quantitative Chemical Analysis, by Charles M. Allen. 20x26.5 cm. Paper. 1913. John Wiley and Sons, New York City.

General Hygiene, by Dr. Frank Overton. 382 pages. 13x19 cm. Cloth. 1913. American Book Company, New York.

First Course in Algebra, by William B. Fite, Columbia University. Pages vii+285. 13x19 cm. Cloth. 1913. D. C. Heath and Company, Boston.

The Constitution of Matter, by Joseph S. Ames, Johns Hopkins University, Pages x+242. 13x20 cm. Cloth. 1913. $1.50 net. Houghton Mifflin Company, New York City.

The Facts about Shakespeare, by William A. Neilson, Harvard University and Ashley H. Thorndike, Columbia University. Pages v+273. 12.5x18 cm. Cloth. 1913. 60 cents net. The Macmillan Company, New York.

The Birds of Connecticut, by John H. Sage, Louis B. Bishop and Walter P. Bliss. 370 pages. 14.5x22 cm. Paper. 1913. Gore, Lockwood and Brainard Company, Hartford.

Plane and Solid Geometry, by Walter B. Ford, University of Michigan, and Charles Ammerman, McKinley High School, St. Louis. Pages ix+321+xxxiii. 13x19 cm. Cloth. 1913. $1.25. The Macmillan Company, New York City.

GUIDE TO SEQUOIA AND GENERAL GRANT NATIONAL PARKS.

Full information regarding the Sequoia and General Grant National Parks, which contain the oldest and largest trees in the world, is contained in a circular just issued by the Department of the Interior. Within these parks are thirteen groves of sequoia trees, there being over 12,000 trees exceeding ten feet in diameter.

In the Giant Forest in the Sequoia National Park the principal trees are the General Sherman, 286 feet high and 36 feet in diameter; the Abraham Lincoln, 270 feet high and 31 feet in diameter; and the William McKinley, 291 feet high and 28 feet in diameter. In the General Grant Park the principal trees are the General Grant, 264 feet high and 35 feet in diameter, and the George Washington, 255 feet high and 29 feet in diameter.

These big trees are the oldest living things in the world, 4,000 annual wood rings having been counted on one of the fallen giants in the Sequoia Park. The great pines of the Pacific Coast are old in their fourth or fifth century, when the big trees growing beside them are still in the bloom of youth, as they do not attain prize size and beauty before their fifteen hundredth year or become old in less than 3,000 years.

This circular, which may be obtained free from the Department of the Interior, contains information regarding the means of seeing the park, tables showing distances to the principal points, a tourist map, a list of birds, and the regulations that have been adopted for the protection of the forest.

BOOK REVIEWS.

Animal Communities in Temperate America as illustrated in the Chicago Region, a study in Animal Ecology, by Victor E. Shelford, Ph. D., of the Department of Zoölogy, the University of Chicago. Pages xiii+362. 16x25x2.5 cm. With 2 maps and 306 text figures. 1913. Published for the Geographic Society of Chicago as Bulletin No. 5, by the University of Chicago Press, Chicago, Ill., Price, $3.00 net.

This is a pioneer work on animal ecology. Plant ecology is now well organized, thanks to Professor Cowles and his co-workers, but for some reason, perhaps because of the comparative ease and interest of morphological studies and a corresponding lack of interest in and appreciation of ecological studies of animals, animal ecology has found no champion till now. The new field always entails greater labor for the investigator and this one is no exception to this rule. The amount of labor expended by Mr. Shelford in the preparation of the studies upon which this work is based must have been very great. The scope of the work can be appreciated best by a resumé of the chapter topics. Chapter I treats in a general way of "Man and Animals"; Chapter II, "The Animal Organism and Its Environmental Relations," followed by a study in Chapter III of "The Animal Environment." In Chapter IV "The Conditions of Existence of Aquatic Animals" are discussed, followed by chapters successively on "Animal Communities of Large Lakes," "of Streams," "of Small Lakes," and "of Ponds." Then the "Conditions of Existence of Land Animals" are discussed in Chapter IX, followed by chapters on "Animal Communities of the Tension Line between Land and Water," of "Swamp and Flood Plain Forests," of "Dry and Mesophytic Forests," of "Thickets and Forest Margins," and of the "Prairie." In a final chapter there is a discussion of the general laws which may be discovered in the study of animal communities. There is a bibliography of authors and works which will be very valuable to the student.

Mr. Shelford has done a good work and one of much value. The book is a store-house of information, aside from its organization of the subject and should be in the library of every teacher of zoölogy. W. W.

Entomology with Special Reference to Its Biological and Economic Aspects, by Justus Watson Folsom, Sc. D. (Harvard), Assistant Professor of Entomology at the University of Illinois. Second revised edition with 4 plates and 304 text figures. Pages vi+402. 10x18x2.5 cm. 1913. P. Blakiston's Son and Co., Philadelphia. Price, $2.25 net.

This revised edition of Prof. Folsom's Entomology has had much new matter added—particularly a chapter on the transmission of diseases by insects. It is a book that will be very useful to the teacher of zoölogy in high and other secondary schools because so much space is given to discussions of topics not usually found in books of classification. About 150 pages are given to classification, anatomy and physiology, and development and about 200 pages to such topics as the following: "Adaptations of Aquatic Insects"; "Color and Coloration"; "Adaptive Coloration"; "Relation to Plants"; "Relation to Other Animals"; "Transmission of Diseases"; "Interrelation of Insects"; "Behavior"; "Distribution"; "Relation to Man." A selected bibliography arranged topically occupying about 45 pages will be very helpful to students and readers desiring to investigate any topic more fully.

Altogether the book will be found very helpful to the general reader as well as to the teacher, supplementing as it does the standard works on classification. W. W.

A System of Questions and Problems in Chemistry by Floyd L. Darrow, Polytechnic Preparatory School, Brooklyn, N. Y. 128 pages. 13x20 cm. Paper. 1913. 40 cents. F. L. Darrow, 99 Livingston St., Brooklyn, N. Y.

A helpful book for both teacher and pupil, a big time saver, too, for the teacher. It is intended primarily for the use of the pupil in preparing his daily lesson. It contains a synopsis of the day's work, put up in the question form. The use of the book will enable the pupil to prepare his lesson with a high degree of efficiency as it tells him what to study, as well as how to do it, by compelling him to think. All chemistry teachers should possess a copy. C. H. S.

Experimental Wireless Stations, by Philip E. Edelman. 224 pages. 14x20 cm. Cloth. 1914. $1.50. Published by the author, Minneapolis, Minn.

As indicated by its name, this is a book intended for that very large class of experimenters in wireless who are interested in the subject, for its sake, as a pastime, as a study and, really, from any cause. It is a splendid book for the secondary school boy in physics.

One of the fundamental objects for which the book stands is to bring about a common standard of wireless apparatus among amateur operators. By describing thoroughly modern instruments the book will wonderfully help in bringing about a common understanding among operators. It aims to make wireless telegraphy more than a pastime. A close and faithful study of it, together with the required experimental work, will enable one to become thoroughly proficient in the art and ready to fill any position to which this knowledge will entitle him.

It is written in a clear and forcible style. There are eighty original drawings, illustrating the subject matter. Most of the matter given has come from the author's own experience.

It is a valuable and useful book looked at from all angles and is one which all physics teachers giving courses in wireless should possess.

C. H. S.

Logarithmic Reduction Tables, by Charles J. Moore, Ph. D., Austin Teaching Fellow in Advanced Analytical Chemistry in Harvard University. Pages viii+78. 15x20 cm. 1913. Price, $1.00. Ginn and Company, Boston.

Students of analytical chemistry and chemists employed in trades and manufacturing industries will find use for these tables, which cover gravimetric, volumetric, and gas analysis. The twenty-nine tables include such subjects as: The atomic weights of the elements and their logarithms, molecular weights of common compounds and their logarithms, reduction of compounds found to constituents sought by multiplication, reduction of barometic readings to 0°, tension of aqueous vapor, reduction of water pressure to mercury pressure, reduction of the volume of gases to normal pressure, density of dry atmospheric air at 760 mm. pressure and temperature ranging from 0° to 35°, and density and specific volume of water at temperature from 0° to 35°. H. E. C.

Tables and Formulas, by William R. Langley, Ph. D., Assistant Professor of Mathematics in the Sheffield Scientific School, Yale University. Pages v+31. 13x19 cm. Price 50 cents. 1913. Ginn and Co., Boston.

This collection of tables and formulas is designed for the use of students in technical schools and colleges in solving numerical problems in analytic geometry, calculus and applied mathematics. It includes the following: Four-place logarithms to base 10; natural values of the trigonometric functions and their logarithms; radian equivalents of degree measure; natural values of trigonometric functions for angles in radian measure; squares and cubes, square roots and cube roots of numbers to 100; reciprocals of numbers from 1 to 10 at intervals of .1; Naperian logarithms of numbers from 1 to 10 at intervals of .1; exponential and hyperbolic functions. The twenty pages of formulas include the important formulas in algebra, geometry, trigonometry, analytic geometry, formulas for differentiation and a table of integrals. H. E. C.

Introduction to Biology, an Elementary Text-book and Laboratory Guide, by Maurice A. Bigelow, Ph. D., Professor of Biology in Teacher's College, Columbia University, and Anna N. Bigelow, M. S., Teacher of Biology in Miss Chapin's school for girls, New York. 119 text figures. Pages ix+424. 13x19x2.5 cm. 1913. The Macmillan Company, New York. Price, $1.10.

The authors have prepared this second book of biology for the use of first or second year classes in high schools. It is intended to be introductory and not take the place of courses in botany and zoölogy. It would thus be used in the first year of high school, followed by botany or zoölogy in the second year. Practically we know that few school curricula will allow so much time for the biological sciences. If there is to be an introductory science, it is more likely to be general science introductory to both the biological and physical sciences.

The book before us is very well planned by topics instead of the usual plan of alternating chapters on plants and animals. We are glad of this for it is a step in the right direction. On examination, however, we find it somewhat cyclopedic with a vast amount of information in condensed statements. There are comparatively few illustrations to vary the monotony of paragraphs packed full of information. We venture to predict that the book will prove to be too heavy a load for first year classes. It might find a place in second year classes where only a year can be given to biological subjects—but even then would need the guidance of an expert teacher to make it successful. Biology which does not enthuse the pupil is worse than useless by creating a dislike for what should be an intensely interesting subject. W. W.

Algebra, First Course, by Edith Long, Head of the Department of Mathematics, High School, Lincoln, Neb., and W. C. Brenke, Professor of Mathematics in the University of Nebraska. Pages viii+283. 13x19 cm. Price $1.10. 1913. The Century Co., New York.

Under the title, "Correlated Mathematics for the Secondary Schools," the authors have produced this algebra, which is to be followed by a geometry text. In the present volume there is an attempt to unite the subjects of algebra and geometry by a constant use of constructive geometry in connection with the algebraic work. Moreover, there is a correlation with physics by means of problems and exercises based on laboratory experiments and experiments to be made by individual pupils in the algebra class room, or by the members of the class together. The efficiency of mathematics teaching will be greatly increased when teachers who realize the value of the laboratory method abound in our schools. For this reason it is to be hoped that this book will have a wide use and that teachers will be willing to prepare for the experimental work. Although there is in this book much drawing and experimental work the formal side of algebra is not neglected, and there is an abundance of exercises and problems for drill in manipulation.

There are some errors which should be corrected in the next edition. If pupils are to learn something of thermometers, levers, specific gravity, and so on, the information so far as it goes should be exact. What is said about the boiling point of water, the gram, density, forces, and so on, and what is not said about the weight of the lever in solving lever problems leaves much to be desired. One possibly wonders if the introduction or continuance of such topics as the commutative and distributive laws, the absolute value of a number, the derivation of the quadratic formula by factoring, and some rather complicated explanations of simple things are due to the university end of the authorship. H. E. C.

Handbook of Physiology, by W. D. Haliburton, M. D., LL. D., F. R. C. P., F. R. S., Professor of Physiology, King's College, London. Eleventh edition. 577 illustrations, many of which are colored and three colored plates. 8 volumes. Pages 923. 1913. P. Blakiston's Son and Company, Philadelphia. Price, $3.00 net.

This is a new and revised edition of a well-known work. The whole book has been thoroughly revised while some chapters have been entirely rewritten. New matter has been added on some important topics. The entire book has thus been brought up to date by the incorporation of recent additions to our knowledge through research and experiment.

It hardly seems worth while to call attention to the various excellencies of such a standard work as this physiology. Students everywhere will welcome this revised edition because of the rapid advance in our knowledge of human physiology. W. W.

Pocket Cyclopedia of Medicine and Surgery, based upon the second edition of Gould and Pyle's Cyclopedia of Practical Medicine and Surgery. Second edition revised, enlarged and edited by R. J. E. Scott, M. A., B. C. L., M. D., New York. Flexible leather. 9x15 cm. 1913. P. Blakiston's Son and Co., Philadelphia. $1.00 net.

This little cyclopedia is intended primarily for medical men, but it will prove a very handy reference book for family use as well. A vast amount of information of a medical nature is packed away in little compass and ready for use at a moment's notice. The information seems to be thoroughly up to date as indicated by the various topics of common interest and knowledge examined by the reviewer, such as typhoid fever, etc. The matter seems to be well selected and there are many handy tables. W. W.

Exercises in Farm Dairying, by C. Larsen, M. S. A., Department of Dairy Husbandry, South Dakota State College. An elementary manual for agricultural high schools and colleges. A practical guide for farmers and dairymen. 20.5x26.5 cm. 1913. John Wiley and Sons, Inc., New York.

This is a loose-leaf manual, each leaf presenting a complete exercise and printed on one side only. The typography of the book is excellent, the type being large and clear and the numerous tables for student reports neatly arranged.

The reviewer has only praise for this manual. Its appearance, the topics, the well-planned exercises, all seem admirable. Such a book as this is needed to systematize and standardize the teaching of this subject. It will be most helpful to those teachers who are trying to present the subject with inadequate facilities. W. W.

Animal Husbandry for Schools, by Merritt W. Harper, Assistant Professor of Animal Husbandry in the New York State College of Agriculture at Cornell University. Pp. xxii+409. With 152 illustrations. 1913. The Macmillan Company, New York. Price, $1.40 net.

This is an admirable book and one much needed. Many schools are attempting to teach agriculture without adequate facilities. Good text-books will do a great deal to put the subject on a better footing and gain for it better recognition and facilities. The present book is "intended to be practical." We think the author has not only succeeded in being practical, but has presented us a well arranged and well planned book.

The horse is considered first with the following chapters: "The Breeds of Horses"; "Judging Horses"; "Principles of Feeding"; "Feeding Horses"; "Care and Management of Horses." All of these chapters are carefully treated under appropriate sub-headings. The other general topics presented are: "Cattle"; "Sheep"; "Swine"; "Poultry." There is an appendix giving a set of laboratory exercises for use with the book and also sections on the "Agricultural Library"; "Addresses of Agricultural Colleges and Experiment Stations"; "Average Weights of Feeding Stuffs"; "Energy Value of Feeding Stuffs"; "Digestible Nutrients in Feeding Stuffs."

The cuts are well chosen and adequate for the subject. The book is a credit to the author, and to the publishers. W. W.

Modern Problems of Biology, lectures delivered at the University of Jena, December, 1912, by Charles Sedgwick Minot, Director of the Anatomical Laboratories, Harvard Medical School; Exchange Professor at the Universities of Berlin and Jena, 1912-13. With 53 illustrations. ix+124 pages. 1913. P. Blakiston's Son and Co. Price, $1.25 net.

Charles Sedgwick Minot is well known to the scientific world for his vigorous work and his writings at the Harvard Medical School. That, as Exchange Professor at Jena, he would still further distinguish himself and honor his profession by his lectures goes without saying. The lectures were written and published in German. The present edition is a translation of the German text.

There are six lectures on the following topics: "The New Cell Doctrine"; "Cytomorphosis"; "The Doctrine of Immortality"; "The Development of Death"; "The Determination of Sex"; "The Notions of Life." These topics are all presented in a simple manner and a perusal of the lectures helps us to appreciate the limitations of our knowledge. It is worth while now and then to take some time from the hurry and stress of our work to study such topics as these. W. W.

The Pupils' Arithmetic, by James C. Byrnes, Julia Richman, and John S. Roberts, New York. Pages viii+258. 13x19 cm. Price 40 cents. 1913. The Macmillan Company, New York.

Book Six of "The Pupils' Arithmetic" was reviewed in the November number of this Journal. Book Five contains a comprehensive treatment of the topics usually taught in the seventh year. It includes also business forms, simple accounts, foreign moneys, the metric system, and introduction to algebra. The solution of simple equations and of arithmetical problems by algebraic methods is well done and should give the pupils a good grasp of simple algebraic work. H. E. C.

Trigonometry (Revised Edition), by Frederick Anderegg, Professor of Mathematics in Oberlin College and Edward D. Roe, Jr., Professor of Mathematics in Syracuse University. Pages ix+108. 13x19 cm. Price 75 cents. 1913. Ginn and Company, Boston.

In the sixty-six pages given to plane trigonometry the fundamental principles are presented clearly and concisely. The demonstrations and definitions are general and special cases are avoided. The number of problems and exercises is small and there are very few practical problems. This book will prove of interest to instructors who wish to emphasize the framework of trigonometry without taking time to show its use and applications in various fields. H. E. C.

A First Course in Algebra, by Frederick C. Kent, Associate Professor of Mathematics, University of Oklahoma. Pages vii+249. 13x19 cm. Price, $1.00. 1913. Longmans, Green and Co., New York.

The author states that two ends have been kept in view in the preparation of this book. "First, to give the student who will take no more algebra a good general working knowledge of the subject, sufficient for any elementary course in science, industrial life, business, etc., second, to furnish a thorough foundation for the more advanced courses of those who are to continue their studies in the university." This book seems to follow the lines of the other new books in algebra, giving a large number of problems dealing with physics, geometry and so on. The graphical work is of old type, starting out with the representation of equations and going no farther. The solution of equations and working of problems is made the chief end throughout the book, and the problems seem to be well chosen. H. E. C.

A Text-book on the Teaching of Arithmetic, by Alva W. Stamper, Ph. D., Head of the Department of Mathematics, State Normal School, Chico, Calif. Pages 284. 13x19 cm. 1913. American Book Company, New York.

While all teachers of arithmetic can learn much from this volume that will be of real value in their work, teachers new in the service should by all means lighten the burden of teaching and make their work efficient by a study of this book. It goes so thoroughly into all the details of processes, explanations, and reasoning that the teacher can get a complete understanding of the subject and present clear and vivid explanations to her pupils. The titles of the chapters indicate the ground covered "History of Arithmetic"; "Reasoning Involved in Arithmetic"; "Preliminary Steps"; "The Principal Operations"; "The Application Side, Percentage, Forms and Measurements"; "Algebra and Geometry in the Elementary School, the Teacher's Preparation of the Lesson"; "In Relation to Schoolroom Practice"; "Supervised Teaching of Arithmetic in Teachers' Training Schools"; "In Relation to the Course of Study." A list of books for teachers and a comprehensive index close this interesting and valuable book. H. E. C.

Computing Tables and Formulas, by E. H. Barker, Head of the Department of Mathematics in the Polytechnic High School, Los Angeles, Calif. **Pages v+88. 10x17 cm. Price 75 cents. 1913. Ginn and Company, Boston.**

These tables, planned for the use of high school students, include the following subjects: Convenient equivalents; powers, roots, circumferences and areas of numbers from 1 to 1000; five-place logarithms of numbers; five-place logarithms of angle functions; natural angle functions; minutes as decimals of a degree; formulas for the solution of triangles; trigonometric formulas; areas and volumes; volumes of spheres; standard gauges; decimal equivalents of common fractions; specific gravities; and weight of a cubic foot of various materials.

The shape and size of the book make it convenient for pocket use, but the print is rather small for long continued study. H. E. C.

Plant Life and Plant Uses, an elementary text-book, a foundation for the study of agriculture, domestic science or college botany, by John Gaylord Coulter, Ph. D. Pages xvi+464. 13x18.5x2.5 cm. 230 text figures. 1913. American Book Company.

The author has set out to do some very commendable things. He says in the preface, "This book is for boys and girls who study about plants. It is a book about the fundamentals of plant life, and about the relations between plants and man more than it is a text-book of botany." . . . "The book seeks to give its reader a certain *appreciation* of plants and of the relationship of plant life to his own life." . . . "The manner of the book has been determined by a desire to make what is important seem interesting to young readers."

We are glad to be able to say that the author has not forgotten his text as he commenced to write and has really written a book for young people in language that they can appreciate. Few text-book writers for high schools appreciate the limitations of the average high school pupil, especially in the first and second years of the school. Frankly, the high school text-books that can be read appreciatively by high school pupils are very few.

In the earlier pages of this book we find many passages of really fine writing. Toward the last, however, there is a relapse and scientific terms crowd each other. In one paragraph of seven lines, on page 403, we find 13 scientific terms. Such paragraphs are about as easy to read by the average youngster as a paragraph of Latin. While the use of scientific terms is, of course, a necessary function of any scientific treatise, the number of such terms in an elementary text-book should be rigidly restricted. We think the author has used more of them than was necessary. It is not necessary, for instance, on page 245 to give the name of the layer that cuts off the leaf in the auutmn. The author has prepared a table of important terms used in the book for review purposes—a very good idea—and we find in this table 477 of these terms and phrases—all supposed to be assimilated by the pupil. And this book is no worse than other text-books of botany in this respect!

We find many things to commend. The language is, we think, within the ability of the second year high school pupil to understand. There is a continuity throughout the book that will do much to make the study interesting. The presentation of the topics is logical and always scientific, but with the life interest of the plant for us always in view. And most commendable of all, the non-vascular plants are compressed into one chapter of 50 pages. We are glad that Mr. Coulter has given us this book. It appears to be a good book and we predict that it will be successful in use. W. W.